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THE LACTOGEN CONTENT OF THE PITUITARY GLAND OF THE LACTATING RAT[1]

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INTRODUCTION

The first evidence that the anterior lobe of the pituitary gland played a rôle in the control of lactation was presented by Grueter (1). Since this pioneer work a large number of investigators have reported the initiation of lactation following the injection of anterior lobe extracts containing the lactogenic hormone. With the development of the hypophysectomy technique it was demonstrated that the anterior lobe is necessary for the initiation and maintenance of lactation. Replacement therapy in pituitaryless animals then showed that the lactogenic hormone is one of the anterior lobe principles required in order to initiate and maintain lactation. Other than the establishment of the above facts, little was added to our knowledge concerning the lactogenic hormone until Reece and Turner (2) assayed the pituitary glands from animals, under various physiological conditions, for their lactogen content.

At the present time it is impossible to obtain an extract of the lactogenic hormone entirely free from other anterior lobe principles. Until such an extract can be obtained one is not justified in concluding that the responses elicited following the injection of the lactogenic hormone are due entirely to this hormone. To date rather contrasting results have been observed following the injection of lactogen preparations. Folley and Young (3) reported that the injection of lactogen caused an increase in milk yield of 30 per cent above the original daily yield. It should be added that these investigators stated that their lactogen preparation was negligibly gonadotropic and thyrotropic, but possessed high glycotropic activity. That a glycotropic factor may have an augmenting influence on milk secretion is suggested by the work of Graham and Jones (cited by Graham, Turner, and Gomez (4)). On the other hand Asimov and Krouze (5) reported that a lactogen prepara-

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tion gave an increase in the milk yield of some cows, only when injected in doses ten or more times as large as those of the crude extract required to give a positive response. Due to the fact that such large quantities of lactogen had to be injected in order to secure a positive response, it is suggested here that the response was probably brought about by anterior lobe principles other than lactogen.

The present work was carried out in an attempt to obtain additional information on the function of the lactogenic hormone during the lactation cycle. Reece and Turner (6) have reported already on the lactogen content of the lactating rat pituitary gland. Their assay work, however, was not carried out on the same group of pigeons and was done prior to the time that the influence of suckling on the lactogen content of the pituitary gland was demonstrated (7, 8).

EXPERIMENTAL PROCEDURE

Thirty-six pregnant rats were divided into three groups designated hereafter as groups I, II, and III. The date and hour of delivery were recorded for each litter. The hour of delivery was taken as the time when the young were first observed in the nests. The rat colony was under observation from 7 A. M. until 10 P. M. The number of pups in each litter, with one exception, was fixed at six, for it was thought that the number of suckling young might influence the lactogen content of the pituitary gland.

In group I the pups were removed from the mothers 36 hours after they were dropped, in group II they were removed 15 days after they were born, and in group III they were removed 22 days after delivery. The mother rats were sacrificed 15 hours after the pups had been removed in order to standardize the influence of suckling on the lactogen content of the pituitary gland. Mother rats were weighed and their pituitaries removed and weighed.

Each pituitary gland was macerated in an agate mortar and suspended in 1.5 cc of distilled water. The suspension was then divided into two equal parts. Suspensions of group I were assayed against those of groups II and III and suspensions of group II were assayed against those of group III. Each combination of suspensions was injected into the same group of common pigeons, thus ruling out animal variability in the assay work. The results are expressed in bird units of lactogen per pituitary gland and per mg. of pituitary tissue (for a detailed description of the assay method refer to Reece and Turner's (2) work).

All of the rats employed in this study were fed the following ration:

Yellow corn	76.0%
Linseed oil meal	16.0
Crude casein	5.0
Ground alfalfa	2.0

Sodium chloride	0.5
Calcium carbonate	0.5.

To this grain mixture 5% of butter was added after grinding. Fresh whole milk was fed daily and lettuce once each week.

EXPERIMENTAL RESULTS

When the pituitaries from group I were assayed against those of group II the glands from group I yielded slightly more lactogen than those from group II. On the average, the pituitary glands in group I contained 10.84 bird units per gland, those in group II assayed 9.46 bird units. This slight difference in the lactogen content of the pituitary glands in these two groups was due primarily to a difference in the concentration of the hormone in the glands, because in group I the glands contained 1.2 bird units per mg. of pituitary tissue and those in group II 1.06 bird units per mg. Out of the 12 comparisons that were made between group I and II, eight of the pituitary glands from rats in group I contained more lactogen than those in group II, two were equal, and two contained less lactogen.

Upon assaying the pituitary glands in group I against those in group III it was found that the glands in group I contained 10.20 bird units per gland, those in group III contained 7.58 bird units per gland. This difference was due entirely to a greater lactogen concentration in the glands of group I, because the glands in group I were no larger than those in group III. Of the 12 comparisons that were made 9 of the pituitaries in group I contained more lactogen than those in group III, two were equal, and one contained less lactogen.

Twelve assay comparisons were made between groups II and III. The average results were as follows: group II, 9.71 bird units per pituitary gland and 1.09 bird units per mg. of pituitary tissue; and group III, 9.04 bird units per pituitary gland and 0.99 of a bird unit per mg. of pituitary tissue. Six of the pituitary glands from rats in group II contained more lactogen than those in group III, three were equal, and three contained less lactogen.

If one averages the assay results for each group in the two comparisons the following figures are obtained: group I, 10.52 bird units per pituitary gland and 1.17 bird units per mg. of pituitary tissue; group II, 9.59 bird units per gland and 1.08 bird units per mg. of pituitary tissue; and group III, 8.31 bird units per pituitary gland and 0.92 of a bird unit per mg. of pituitary tissue. These results are summarized in Table I.

DISCUSSION

In assay work of this type the question is frequently asked whether or not the hormone content of a gland is a reliable measure of the amount of hormone being discharged into the blood stream. With reference to the lactogenic hormone, the extensive assay results of Reece and Turner (2), with

TABLE I

Lactogen content of the pituitary gland of the lactating rat

No. of Animals	Group Number	Body wt. when sacrificed gm.	Pituitary wt. mg.	Bird units per pituitary gland	Bird units per mg. of pituitary tissue
{ 12	I*	220	9.0	10.84	1.20
{ 12	II*	244	8.9	9.46	1.06
{ 12	I	220	9.0	10.20	1.13
{ 12	III*	236	9.0	7.58	0.84
{ 12	II	244	8.9	9.71	1.09
{ 12	III	236	9.0	9.04	0.99
12** ...	I	220	9.0	10.52	1.17
12** ...	II	244	8.9	9.59	1.08
12** ...	III	236	9.0	8.31	0.92

{ Glands assayed in same group of pigeons.

* The pituitaries were taken 15 hrs. after the pups were removed from the females. In group I the pups were removed 36 hrs. after they were dropped. In group II they were removed 15 days after they were born. In group III they were removed 22 days after they were dropped.

** Average figures.

one exception, demonstrated that a pituitary gland with a high lactogen content is one that is actively discharging the hormone into the blood stream.

There was not a very marked difference in the lactogen content of pituitary glands taken from rats in three stages of the lactation cycle. It is possible that animal variability overshadows the influence of the stage of lactation on the lactogen content of the pituitary gland. If such is the case, animal variability can be ruled out only at a time when one is able to determine the amount of lactogen being excreted by the same animal over the entire lactation cycle.

The results secured show that the lactogen content of the pituitary gland was highest shortly after parturition. Following this time there was a gradual fall in the lactogen content of the pituitary gland until the end of the lactation period. A high pituitary lactogen content was not associated with the peak of the lactation curve and therefore suggests that the lactogenic hormone plays no important part in determining the height of the lactation curve. Inasmuch as there is a gradual fall in the pituitary lactogen content as the lactation cycle continues it seems probable that this hormone may be a factor in determining the rate of decline in milk production.

SUMMARY AND CONCLUSIONS

The pituitary glands collected from rats 51 hours after parturition contained 10.52 bird units per pituitary gland, those glands collected from rats 16 days following delivery contained 9.59 bird units per gland and those collected from rats 23 days after delivery contained 8.31 bird units.

On the basis of these results it is suggested that the lactogenic hormone plays no major rôle in determining the height of the lactation curve, but may be a factor in determining the rate of decline in milk production.

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THE SITE OF FAT SYNTHESIS IN THE MAMMARY GLAND[1]

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The organization of materials around the milk fat particle and the fact that the fat content of milk may be affected without influencing the amount of milk, suggests that milk fat is synthesized more or less independently from the other milk constituents. This naturally leads to the possible hypothesis that the milk fat nay be synthesized in a different portion of the secretory epithelial cells. On this basis, work was begun first to establish the point of synthesis of milk fat and secondly to ascertain the mechanism of milk fat synthesis. To gain information on these points, three methods of attack were used: 1) stained fat was fed, 2) biochemical analyses of the gland were made, and 3) histochemical techniques were utilized. Reports on these studies follow in the order named.

PART ONE

FEEDING OF STAINED FAT

The work of Mendel and Daniels (7), and Gage and Fish (3), which give reviews of the previous literature, indicate that Sudan stained fat fed to lactating cows does not enter milk in its stained form. It is believed possible, however, since the stain was present in the blood after feeding that it might be found in the active secretory portion of the mammary gland. If this were the case, a histological study of such a gland would be of aid in the study of milk fat synthesis.

PROCEDURE

Two cows were fed butterfat or peanut oil which was previously stained with Sudan IV. One of these, a Jersey, was fed approximately 27 grams of the stain in a ten day feeding period. The other, a Holstein, ingested 15 grams of the Sudan IV in a nine day feeding period. Each cow was slaughtered at the end of her feeding period. Samples of milk were taken both before and during the feeding period. The carcass of each animal was inspected for the presenee of Sudan stained adipose tissue. Each udder was immediately excised, and sections were placed in fixing solution for histochemical analysis. The remainder of the mammary tissue was frozen and kept in that condition until used for analysis.

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[1] A portion of the thesis submitted to the graduate school of the University of Minnesota by the senior author in partial fulfillment of the requirements for the degree of Doctor of Philosophy plus additional material from research at the University of Arkansas Agricultural Experiment Station.

[2] Now at the University of Arkansas.

[3] Paper No. 1671 Scientific Journal Series, Minnesota Agricultural Experiment Station. Research paper No. 627 Journal Series, University of Arkansas.

RESULTS

No definite evidences of the stain were detected in any of the body fat, udder tissue or milk fat. The adipose fats were a deep yellow color in each instance. There was no evidence to indicate that the adipose tissue of the body had been colored by the stain in any case. The udders were of normal color, and the fat globules of the alveoli did not appear to contain any of the stain. The milk fat was treated with various solvents in an effort to extract evidence of the presence of the stained fat, but the results were negative.

Attempts were made to separate the gland fat of the udder of the Jersey cow into fractions which would yield more intense color reactions. The alcoholic extract of the gland was of a deep yellow color. After filtering this extract and driving off the alcohol on an electric hot plate using a sand bath, ethyl ether and water were added and the two fractions were separated in a separatory funnel. The ether extract when concentrated was deep red in color. The water extract when concentrated was also deep red in color. When the latter was treated with very dilute sulphuric acid a red precipitate which was soluble in dilute ethyl alcohol floated to the top. For comparison an extract was made from the secretory tissue of another Jersey cow which was not fed stained fat. Here the concentrated ether extract was deeply colored, but instead of the deep red color noted in the water fraction in the gland of the Jersey cow which was fed the stained fat, this water fraction was almost colorless. Extracts of the milk fat from the cows fed the stained fat were saved both before and after the beginning of the fat feeding periods and treated in the same manner. The water extract in all four instances was colorless.

DISCUSSION OF RESULTS

This adds evidence to the possibility that the molecules of the stain become conjugated after they enter the body and become water soluble instead of fat soluble. This work was not carried further though it is interesting to note that the water soluble fractions, isolated from the udder of the cow fed stained fat, acted very similarly to the fractions worked on by Salent and Bengis (12) who worked with cats and rabbits, to study the metabolism of Sudan stains in the animal body.

While there may have been some difference in the color of the ether extracts from the two glands studied, the color was not considered positive evidence of the presence of the stains as various other pigments, such as carotene, were also present.

The work done fully corroborates the previous results of Mendel and Daniels (7), and Gage and Fish (3) that Sudan stained fat fed to lactating cows does not color the resulting milk fat which is produced. There was no definite evidence of the stain in the mammary gland. If present, the stain would be much diluted, and give a yellow rather than a red color.

The presence of natural pigments in the gland tissue would tend to cover up the color of the stain and render it indistinguishable from them.

The fact that the fat in the alveolus was unstained is significant. It is well known that blood fat is stained for some time after the feeding of stained fat. It is also well known that the blood lipides must to a large extent be the milk fat precursors. Since each cow in the experiments reported in this paper received at least one and one-half pounds of stained fat per day, the cows must have utilized some of the stained fat for the synthesis of milk fat. As the fat droplets visible in the alveoli were colorless, one can conclude that the changes which occur in the synthesis of milk fat from the blood precursors must take place before the formation of the fat droplets in the alveoli.

PART TWO

BIOCHEMICAL ANALYSIS

Review of the Literature

One of the authors, Petersen, Palmer and Eckles (9), had previously found that fat which they had extracted from two actively secreting bovine mammary glands had acid values of 8.07 and 11.30. Since acid value refers to the number of milligrams of potassium hydroxide required to neutralize the free fatty acids in one gram of fat, these values indicated that a considerable amount of free fatty acid was present in the mammary gland fat. Preliminary work gave added indications that this was true, and it was decided to make a more detailed investigation.

PROCEDURE

Ten mammary glands in various stages of activity are reported in this study. Since the procedure varied somewhat, the various methods of extraction used will be mentioned in detail. All of the analyses were in duplicate or were the average of four analyses, and the necessary blanks were made. The results are given in Table 1.

Two extractions were made from the gland of Number 430, a Holstein, using different procedures.

First extraction: The udder tissue was frozen with liquid oxygen and ground in a mortar. It was extracted with a 3 to 1 ethyl alcohol-ethyl ether solution. This was evaporated almost to dryness and extracted with ethyl ether and petroleum ether. The ether was evaporated off in an air current, alcohol was added and the solution was titrated with aqueous sodium hydroxide using phenolphthalein as an indicator. An alcohol-ether extraction was made from 10 grams of the original tissue in a Soxhlet extractor. From the information obtained the acid value of the fat was calculated. These data are given in Table 1.

Second extraction: The frozen tissue was ground as finely as possible in a meat chopper, and mixed with five times its weight of plaster of Paris. A measured volume of ethyl ether was added to this mixture and shaken

occasionally during the next few hours. After a final shaking, the mixture was allowed to settle, the clear extract at the top was decanted and its volume measured. This was called extraction Number 1. Two 25 cc. aliquots were titrated with aqueous sodium hydroxide. More ether was added to the calcium sulphate and udder tissue, and the same process was repeated for extraction Number 2. In this manner six extractions were made over a period of several days. When the final extraction was made, the first volume decanted was subtracted from the total volume of the ether added the first time in order to learn the volume of ether which remained in the calcium sulphate and udder tissue. This volume was considered as part of the final extraction. On the basis of these aliquots the total acidity of the extract could be calculated. This information, with that learned from the Soxhlet extractions, gave the necessary data for the calculations.

The second gland analyzed was ground as finely as possible with a meat chopper, and the tissue was extracted with small amounts of ethyl alcohol and later ethyl ether. These combined extracts were extracted with ethyl ether in a separatory funnel. The ether extract was placed in an evaporating dish, and the ether was blown off with an electric fan. The dried fat was purified with benzene, it was filtered, the benzene was driven off, and the weight of the fat was obtained. It was dissolved in equal parts of benzene and ethyl alcohol and titrated with aqueous sodium hydroxide using phenolphthalein as the indicator.

After grinding with a meat chopper, the remainder of the glands analyzed were mixed with five times their weight of anhydrous calcium sulphate and extracted in a continuous extractor with ethyl ether. The fat obtained was taken up in either benzene or petroleum ether. Weights and titration values were obtained using the same reagent and indicators as in the previous analyses.

RESULTS

A summary of the analyses is listed below:

TABLE 1

Analysis of the fat extracted from bovine mammary glands

Cow No.	Acid value	Remarks
430	18.63	End of a prolonged lactation period.
7	13.21	Dry gland.
82	38.20	Actively secreting gland from a cow which had been fresh two months.
5	37.58	In active secretion, but tissue of unknown origin from a slaughter house.
3	18.11	Dry gland from a shorthorn cow which would have freshened in about 2 weeks.
6	17.90	Dry gland from a non-pregnant cow which had been dry 8 months.
73	22.84	Dry gland from a cow milked four months and dried without further milking. Was dry 27 days before slaughter.
Mixture of 3 glands	.72	Slaughterhouse tissue from the glands of a yearling heifer which was not carrying a calf.

DISCUSSION OF RESULTS

A study of the data in Table 1 points to a close relationship between the stage of activity of the gland and the amount of free fatty acid which is present. Glands which have not undergone the development of pregnancy contain only a trace of this material. The acid values of the fat from the secretory tissue of glands which had previously been in active secretion, but which were in a resting state at the time of analysis, varied from 13.21 to 22.84. Two actively secreting glands had acid values of 38.20 and 37.58, while a third gland from a cow which was at the end of prolonged lactation period yielded an acid value of 18.63. Neither blood fat, which must to some extent be the precursor of milk fat, nor milk fat which is the finished product of milk fat synthesis, contain appreciable amounts of free fatty acid. The fact that there is a close relationship between the stage of activity of the gland and the amount of this material present in the secretory tissue, and also that such comparatively large amounts are present during active secretion suggests that free fatty acids are involved in the actual process of milk fat synthesis.

PART THREE

HISTOCHEMICAL ANALYSIS

As the preceding biochemical studies had indicated the presence of free fatty acids in the mammary gland fat, histochemical studies were undertaken in the hope of ascertaining where these fatty acids were located in the secretory tissue. Since the specificity of any one stain differentiating neutral fat from free fatty acids is open to question, five different stains were used. The five stains used were: Neutral red, brilliant cresyl blue, nile blue sulphate, Oil Red O, and osmic acid.

Neutral red was chosen as authorities cited by Langeron (5) claim it to stain neutral fats a faint yellow and fatty acids a deep red. This dye also acts as an indicator changing to a red at a pH of 6.8 and to a yellow at a pH of 8.0.

Brilliant cresyl blue was used as the small amount of literature which is also cited by Langeron (5) indicates a general agreement that brilliant cresyl blue has use as a fat stain.

The literature in regard to nile blue sulphate, another of the stains used, is somewhat larger and more controversial. Langeron (5), Lison (6), and Kay and Whitehead (13) have written detailed discussions in regard to the use of this stain. Most are agreed that the red color is quite specific for neutral fats though the blue stain is not as specific in designating free fatty acids.

Oil Red O, another stain selected for use, was found by French (2) and Proescher (10) to give superior results to Sudan III to which it is chemically very similar. This is a general fat stain which stains neutral fats more deeply than fatty acids and sterol esters.

Lison (6) takes exception to the view that Sudan is a differential stain because it adheres to the fats by the phenomenon of simple absorption of the stain by the fat. He maintains that, since this is true, it cannot be used as a differential stain. A similar criticism could not be applied against the use of the stain in alkaline solution. It was noted in making the photomicrographs that the alkaline stain appeared to give differentiation where the neutral stain did not. One of the difficulties in its use is that it is soluble only in solvents which tend to dissolve out the fat. In this work the method of Gross (4) was followed in using a 50 per cent diacetin solution in water as a solvent for the dye.

The various groups of substances differ in their readiness to be oxidized by osmic acid thus causing differences both in the rapidity of staining and in the color produced. Natural fats are blackened the most deeply. Langeron (5) and Lison (6) discuss the use of this stain as a fat stain. Since it stains other compounds besides the fats which are present, extreme care must be taken in interpreting the results obtained from its use. However, since biochemical analysis has shown large amounts of the free fatty acids to be present and as other stains were also to be used, osmic acid was believed to be of possible value in this study.

The method of Romiew (11) was used for detection of cholesterol and sterol esters. This method according to Lison (6) is specific for the detection of these substances.

A test for phospholipides was also made based on the well known fact that these substances are not soluble in acetone which is a solvent for other types of fats.

EXPERIMENTAL PROCEDURE

Portions of the secretory tissue of an active mammary gland were placed in a solution consisting of 10 parts formalin and 90 parts Locke's physiological saline solution. They remained in this solution from 2 to 4 days. The time element was kept as short as possible since Millot and Giberton (8) have shown that too long preservation in formol solution alters the amount of free fatty acid in the tissues. The photographs and drawings were prepared from this material.

Wherever possible the stains were prepared as aqueous solutions. Neutral red and brilliant cresyl blue were made up as 1 per cent aqueous solutions. A 1 per cent aqueous solution of nile blue sulphate was hydrolized with a few drops of sulphuric acid after the method described by Conn (1). Sections of tissue were also stained in the gas fumes of a 2 per cent solution of osmic acid.

EXPERIMENTAL RESULTS

A drawing of portions of the walls of two alveoli with a blood capillary between which was stained with neutral red is shown in Fig. 1. The deep

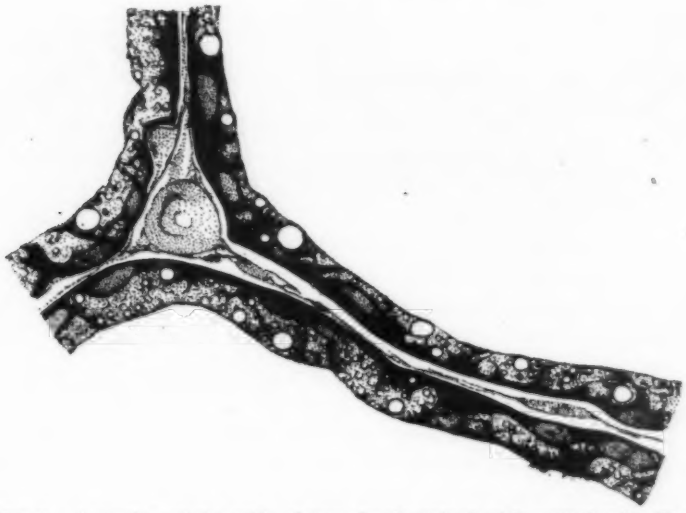

FIG. 1. A portion of the walls of two alveoli stained with neutral red. The free fatty acids are deeply stained while the globules of neutral fat are unstained.

stain represents free fatty acids with the uncolored fat globules as neutral fat. It will be noted that there is a greater concentration of free fatty acid at the base of the secretory cells and a greater concentration of neutral fat in the distal portion.

Figure 2 is a drawing of a section stained with brilliant cresyl blue. The deeper stained free fatty acids and uncolored fat globules are shown

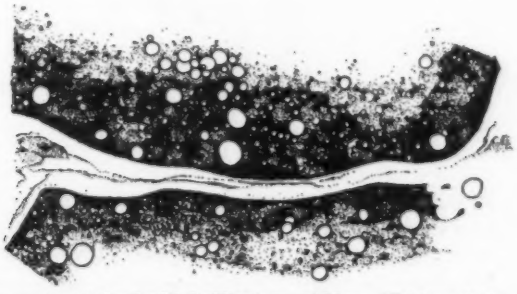

FIG. 2. A section stained with brilliant cresyl blue. The free fatty acids are deeply stained and the fat globules unstained.

in essentially the same position as that indicated where neutral red was used as the fat stain.

When stained with nile blue sulphate (Fig. 3) the same picture is again

FIG. 3. A section stained with nile blue sulphate. The free fatty acids are deeply stained while the globules of neutral fat are unstained.

represented with the free fatty acid in the deeply stained area and neutral fat in the form of fat globules.

Figure 4 is a drawing of a section stained with Oil Red O. The deepest stain is taken up by the neutral fats which are located in the same area as

FIG. 4. A section stained with Oil Red O. The neutral fats take the deepest stain and other fatty substances are less intensely colored.

that indicated by the previous figures where other stains were used. Since this is a general fat stain, staining most types of fats, other fatty substances besides neutral fats and free fatty acids are detected by its use, but it can be observed that besides the neutral fats the epithelial tissue contains other fatty substances. A large portion of this material could consist of free fatty acids from the basis of the observations on the previous sections where other stains were used.

A comparable picture is obtained when the section is stained with osmic acid. See Figure 5. The deepest stained globules, the neutral fats, are

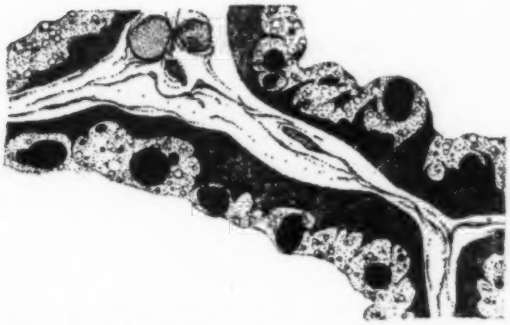

FIG. 5. A section stained with osmic acid. The globules of neutral fat are stained deeply while other fatty constituents are less deeply stained (indicated by stippling).

located in the same areas as in the previous figures. The areas which stained brown (stippled) indicated that other fatty constituents were present.

Photomicrographs were also made for comparison with the drawings.

The Romiew stain, used to indicate the presence of cholesterol and sterol esters, indicated concentrations of these materials in all of the epithelium adjacent to the alveolus.

The results of the technique used to indicate the presence of phospholipides were almost negative. After the extraction with acetone, the tissue took up only a slight amount of osmic acid giving the section a uniform light brown color.

DISCUSSION OF RESULTS

Nile blue sulphate, brilliant cresyl blue, and neutral red, the three stains used for differentiating between free fatty acids and neutral fat, gave the same picture; namely, a positive stain for free fatty acids and for neutral fat. The free fatty acid was distributed throughout the epithelial tissue with the greater concentrations in the basal portions of the cells, while the neutral fats were concentrated to the larger extent in the distal portion of the cells.

Osmic acid and Oil Red O indicate neutral fats to be located in the same position as that indicated by the three previously mentioned stains. While neither osmic acid nor Oil Red O indicate free fatty acid, specifically, they do indicate that there is a concentration of fatty constituents of some type, other than neutral fat, in the secretory epithelium.

Since there was never any evidence that the free fatty acids were present in the form of particles, it is suggested that the free fatty acids are present in either molecular or colloidal state. As they are synthesized into neutral fats there is a change in interfacial tension, causing the particles to coalesce so that at the lumen they are of normal milk particle size.

On the basis of the acid value secured for the total fat of the gland,

there are sufficient free fatty acids present to account for the staining picture when such fatty acids are largely limited to the basal portions of the secretory epithelium.

SUMMARY AND CONCLUSIONS

1. An attempt to trace the course of milk fat synthesis by the use of feeds stained with Sudan stain gave negative results partly because of the apparent changing of the structure of the dye molecule to a water soluble compound.

2. Biochemical studies indicated the presence of quite large amounts of free fatty acids in actively secreting glands. They pointed to a close relationship between the stage of activity and the amount of free fatty acid which was present, with resting glands containing much less of this material than do actively secreting glands. Glands undeveloped by pregnancy contain only a trace of free fatty acid.

3. Histochemical studies with nile blue sulphate, brilliant cresyl blue, and neutral red indicated the secretory cells of the mammary gland particularly in their basal portions, contained free fatty acids. Neutral fats were located near the distal portions of the alveolus. Oil Red O and osmic acid added confirmatory evidence to the results of the previously mentioned stains.

4. It is suggested from the evidence presented that the free fatty acids in the basal portions of the secretory epithelium are present in either molecular or colloidal state.

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RELATION OF VITAMIN C, LECITHIN, AND CAROTENE OF MILK TO THE DEVELOPMENT OF OXIDIZED FLAVOR[1]

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INTRODUCTION

Oxidized flavor is one of the most objectionable off-flavors of milk and one of the most difficult to control. During recent years, in face of greater sanitary precautions, and increased use of pasteurization, oxidized flavored milk has become increasingly prevalent. Increased handling and low bacterial counts seem to favor the development of oxidized flavor. Outbreaks of oxidized flavored milk have been particularly intensive in dairies producing high quality milk, especially if the interval between production and consumption is longer than usual.

Oxidized flavor has been studied rather extensively during the last ten years. Out of these studies has come the knowledge that it is a developed off-flavor that may be catalyzed in various ways such as: exposure to light rays, metal contamination, and heat. In accordance with these investigations, plant operators have taken special precautions in handling milk. Little trouble has been reported during the seasons of the year when pasture and other green feeds are plentiful. During the winter season, however, some milk develops oxidized flavor even when produced under the most sanitary conditions and with the greatest protective efforts against metal contamination and exposure to light. Extreme precautionary measures during the processing and handling operations do not always prevent its occurrence. The production of milk which is relatively non-susceptible to oxidation may be a possible solution of the problem. It seemed desirable, therefore, to study the raw milk from individual cows in an effort to determine any possible relationship of certain milk constituents to the oxidation process.

REVIEW OF LITERATURE

Evidence has been presented that lecithin rather than butterfat is involved in the development of oxidized flavor (11, 12, 13). Some investigators (3, 4, 9) have reported a possible relation between oxidized flavor and the vitamin C in milk.

According to Guthrie and Brueckner (6) there is no relation between

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oxidized flavor and the breed, period of lactation, or age of cows. However, Stebnitz and Sommer (10) found that the butterfat in the milk from Holstein cows was more susceptible to oxidation than that from any other breed, when on winter rations. Milk fat from Guernsey cows had an exceptionally high stability value or peroxide number.

Some of the earliest work relating to feed and oxidized flavor was done by Kende (8) in 1932. His theory for the absence of oxidized flavor in summer milk was that green feeds and fresh hay contain considerable amounts of reducing substances which tend to prevent oxidized flavor. Furthermore, that green feeds seem to lose this reducing substance during storage because of auto-oxidation. In agreement with Kende's observation Brown, Thurston, and Dustman (3) found that by changing cows from dry feed to dry feed plus pasture the milk became non-susceptible to oxidized flavor.

Anderson (1) has shown that carotene may be the substance in green feed which retards the development of oxidized flavor. He found that by supplementing the regular winter ration with five pounds of carrots or five pounds of machine cured hay, oxidized flavor could be eliminated from the milk of a cow that had previously produced oxidized milk. Since these feeds are high in carotene he attributed the improvement in flavor to this substance.

The only indication found by Guthrie and Brueckner (6) of a relation between the feed of the cow and oxidized flavor was the tendency for most cows which produced such milk in the winter not to produce milk that acquired this off-flavor in the summer. They concluded that dry feed was not the sole cause of the development of oxidized flavor since there was a variation in intensity of off-flavor developed in the milk from different quarters of the udder.

Stebnitz and Sommer (10) found that the stability value of fat toward oxidation decreased when cows went on grass as compared with winter rations. According to their results, fat from cows receiving grass as part of their ration is less saturated and therefore more susceptible to oxidation. Yet they found that the milk did not oxidize when the cows were on green feed. They concluded that there are protecting substances in milk in increased amounts when cows are on grass which prevent the development of oxidized flavor. They were unable to find any relation, however, between the carotene in the milk, as indicated by color of fat, and the stability of milk toward oxidation.

EXPERIMENTAL PROCEDURE

This study was undertaken to obtain more information on the occurrence of oxidized flavor in raw milk and its relation to the vitamin C, lecithin, and carotene (as indicated by color of the milk fat) of the milk.

Milk from four breeds of dairy cows in the college herd was studied. The cows used were fed a grain mixture in addition to medium grade alfalfa hay and sorgo silage. They did not receive pasture during the trial, except during the month of May. A group of Holstein cows that were on a special feeding trial were also included in this study. These cows differed from the other cows in that they were receiving prairie hay instead of alfalfa and had never received any green feed since they were six months old. This group will be spoken of as E-Holsteins throughout this paper.

On three consecutive days of each month, samples of morning milk were collected from each of the 60–70 cows in the herd. The samples were collected directly from an aluminum milking pail and placed in glass bottles. These samples were divided into two parts, one part being scored immediately for flavor and tested for vitamin C, while the other part was stored three days at 45° F. before being scored for flavor and tested for vitamin C.

The milk was examined organoleptically by two judges for off-flavors. A system of numbering was used to conceal the identity of the samples from the judges. The intensity of the oxidized flavor was indicated by numbers ranging from one (slightly oxidized) to five (very pronounced). All other off-flavors were recorded, but were not given a rating according to intensity.

Vitamin C determinations were made according to the method developed by Bessey and King (2) and modified by Whitnah and Riddell (14). These tests were made on both the fresh milk and the stored milk, for all samples taken during November to March inclusive.

Horralls' (7) method of determining lecithin in milk was used. Only the amounts of phosphorus in p.p.m. were calculated. The actual amount of lecithin could be determined by multiplying a constant derived from the empirical formula of lecithin (7) with p.p.m. of phosphorus. However, the p.p.m. of phosphorus in an ether extraction of fat is representative of the amount of lecithin in the sample. Lecithin determinations were made on three day composites of milk collected in December and March.

The method used for determining the amount of color in milk fat was developed by Whitnah[3] and used as a relative index of carotene. This method involves the comparison of a clear fat solution with a standard 0.1 per cent potassium dichromate solution in a Klette colorimeter. Color determinations were made on three day composites of milk collected monthly during January to May.

Two feeding trials were conducted in which the regular winter rations of animals that had been producing badly oxidized milk were supplemented with feeds high in carotene. One feed was a carotene concentrate, soluble in fat solvents, and the other was dehydrated green oats. The carotene

[3] Unpublished data by C. H. Whitnah of the Department of Chemistry, Kansas State College.

TABLE 1

Comparison of breeds of cows in frequency of occurrence of oxidized flavor in milk samples collected monthly, November to May

Breed	Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		May		Total	
	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized	No. samples	Per cent oxidized
Jersey	13	0	13	7.7	48	14.6	48	6.3	48	8.3	48	2.1	45	0	263	6.1
Guernsey	11	18.1	12	33.3	42	21.4	39	2.5	38	2.6	36	0	39	0	217	7.8
Ayrshire	12	16.7	14	28.6	39	30.7	39	5.1	35	22.9	27	22.0	30	13.3	196	19.4
Holstein	14	21.4	16	31.3	48	31.3	39	20.5	44	9.1	46	8.7	45	2.2	252	15.9
E-Holstein	9	11.1	9	0	30	0	36	5.5	32	18.7	38	7.9	45	2.2	199	6.5
Total	.59	13.6	64	21.9	207	20.8	201	8.0	197	11.7	195	7.2	204	2.9	1127	11.0

concentrate contained 150 mg. of carotene per pound, and the dehydrated green oats contained 103 mg. of carotene per pound.

In the first trial eight cows were selected, four of which were fed a carotene supplement while the other four were continued as controls on the regular winter ration without supplement. Three cows were fed two pounds per head daily of dehydrated oats and the fourth cow received four pounds daily of the fat soluble concentrate. In the second trial, two cows were fed the fat soluble concentrate at the rate of one pound per head daily, while two cows were continued as before without any supplement.

Both feeding trials lasted ten days. During the trials, samples of milk were collected daily and examined for flavor defects and analyzed for color.

EXPERIMENTAL RESULTS

Table 1 shows the number of samples analyzed each month by breeds and the percentage which developed oxidized flavor. Off-flavors found, other than oxidized were: rancid, salty, feedy, and storage. No significant relation was found between oxidized flavor and any other off-flavor.

Oxidized flavor was detected in 11 per cent of 1,127 samples examined during the regular monthly herd test (Table 1). There was a decided decrease in this flavor defect during the month of May. This improvement in flavor corresponded with the time when the cows received their first pasture after having been fed a winter ration for six months.

Oxidized flavor occurred in 17.4 per cent of all Ayrshire and Holstein samples considered together, whereas it occurred in only 6.9 per cent of all Jersey and Guernsey samples considered together. The E–Holstein cows were as free from the oxidized flavor as the Jersey and Guernsey breeds. The milk produced by this group, however, frequently became so rancid that other off-flavors might have been masked.

Relation of Vitamin C to Oxidized Flavor

The relation of oxidized flavor in milk to both the vitamin C content of fresh milk and the amount of vitamin C lost during a three day storage period is shown in Table 2. The mean vitamin C content of fresh milk is practically the same in the oxidized milks as in the non-oxidized milks. For the Jersey, Guernsey, and Ayrshire breeds, there was a greater loss of vitamin C in the oxidized flavored milks than in the non-oxidized group, yet the reverse is true in the Holstein breed. The correlation coefficients between the vitamin C content of fresh milk and the oxidized flavor rating for 732 samples was only 0.017. The coefficient between the amount of vitamin C lost in three days storage of milk and the oxidized flavor rating was 0.109, which though slightly higher was not significant.

Relation of Lecithin to Oxidized Flavor

The lecithin content, expressed as parts per million of phosphorus, and the prevalence of oxidized flavor in various lecithin intervals are presented

Relation of Milk Fat Color to Oxidized Flavor

The relation of milk fat to oxidized flavor is presented in Table 5. Since the Holstein and Ayrshire breeds do not have such highly colored milk as the Jersey and Guernsey breeds, the results were computed separately. The consistently lower mean color averages for the milks having oxidized flavor as compared with the non-oxidized milks indicate that this flavor defect occurs more frequently in low colored milk. In the 27 samples of milks in the oxidized group (Table 5) only four were above breed average in color. No oxidized samples of Jersey and Guernsey milk were above breed average in color.

TABLE 4

Intensity of oxidized flavor in the milk of cows prior to and after feeding carotene supplement

Date	Oxidized flavor rating*								Date	Oxidized flavor rating*			
	Trial Number 1									Trial Number 2			
	Cows fed supplement				Control cows					Cows fed supplement		Control cows	
	370	134	130	242	249	136	271	E 38		249	382	220	374
Winter feed with no carotene supplement													
Mar. 1	0	4	0	0	5	3	1	1	Mar. 1	5	0	2	0
" 2	1	2	0	1	5	1	1	2	" 2	5	0	3	2
" 3	3	1	1	0	5	0	0	0	" 3	5	0	0	0
" 20	1	1	0	0	2	0	0	3	Apr. 3	5	4	0	0
" 21	0	2	1	1	0	2	0	2	" 4	3	0	1	0
" 22	1	1	0	0	0	3	1	0	" 5	5	0	0	1
Supplement† started March 22									Supplement‡ started April 10				
Mar. 23	1	2	3	3	...	...	...	...	Apr. 11	5	3	...	...
" 24	1	1	1	1	...	...	...	...	" 12	3	1	...	...
" 25	0	0	3	3	...	...	...	...	" 13	0	0	...	...
" 26	0	0	0	0	...	...	...	...	" 14	0	0	...	...
" 27	0	0	0	0	...	...	...	...	" 15	0	0	...	...
" 28	0	0	0	0	...	...	...	...	" 16	0	0	...	...
" 29	0	0	0	0	...	...	...	...	" 17	1	0	...	...
" 30	0	0	0	0	...	...	...	...	" 18	1	0	...	...
" 31	0	0	2	0	...	...	...	...	" 19	0	0	...	...
Apr. 1	0	0	0	0	...	...	...	...	" 20	0	0	1	2
" 2	0	0	0	0	...	...	...	...	" 21	0	0	0	3
" 3	0	0	0	0	5	0	2	1	" 22	0	0	3	3
" 4	0	0	0	0	3	3	4	0	" 23	0	0	...	...
" 5	0	0	0	0	5	2	1	2	" 24	0	0	...	...

* Oxidized flavor rating from 0, which was free from this flavor defect to 5 which was very pronounced.

† Cows 370, 130, and 242 received 2 pounds per head daily of dehydrated green oats containing 103 mg. of carotene per pound. Cow 134 received 4 pounds daily of a fat solvent soluble concentrate containing 150 mgs. of carotene per pound.

‡ Cows 249 and 382 received 1 pound per head daily of the fat soluble, concentrate.

As a further indication that oxidized flavor occurs more frequently in milks of low color intensity it will be noted (Table 1) as mentioned pre-

viously in this paper, that oxidized flavor occurred in 2.5 times more samples of Holstein and Ayrshire milk than it did in Jersey and Guernsey milk. Since the Holstein and Ayrshire breeds are known to give milk of low color, this may possibly explain the breed difference in prevalence of oxidized flavor.

TABLE 5

The comparison of color intensity of milk developing oxidized flavor with milk free from this off-flavor

Flavor grouping	Color score									
	Feb.		Mar.		Apr.		May		Total	
	No. samples	Mean	No. samples	Mean	No. samples	Mean	No. samples	Mean	No. samples	Mean
Jersey-Guernsey milk										
Non-oxidized	25	15.7	25	14.9	27	14.1	28	50.7	105	25.2
Oxidized	3	13.5	3	7.3	1	3.7	0	0.0	7	9.4
Holstein-Ayrshire milk										
Non-oxidized	21	7.9	21	8.9	18	10.3	23	26.7	83	13.8
Oxidized	5	7.1	6	8.4	7	7.9	2	8.2	20	7.9

Color determinations were made on the milk fat of each cow during the feeding trials. These determinations are not shown for the cows in the second feeding trial because several of the samples were accidentally destroyed.

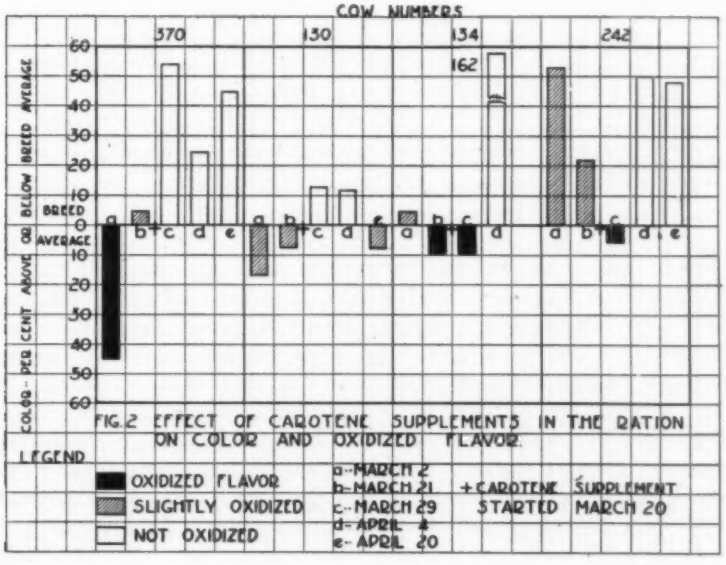

Table 6 and Figure 2 show that there was an appreciable rise in fat color intensity shortly after the cows had received a carotene supplement. In each case oxidized flavor was eliminated as the color intensity increased. Color intensity was increased as much as 162 per cent above breed average after a carotene supplement had been fed (Cow number 134, Table 6, Figure 2). This cow received nearly 400 mgms. more carotene per day than did the other cows in the same group. High color intensity, in comparison with the breed average, did not always prevent the development of oxidized flavor. This was shown by the fact that milk from cow number 242 was slightly oxidized when the color intensity of the milk fat was 53 per cent above the breed average. Her milk, however, was decreasing in color and at the same time the off-flavor was becoming more pronounced. The flavor defect was eliminated entirely after feeding a carotene supplement.

TABLE 6

Effect of carotene supplements to the ration on color intensity of milk fat, and the development of oxidized flavor in milk

Date	Cow number											
	370			130			134			242		
	Color score	Per cent of breed ave.*	Flavor score†	Color score	Per cent of breed ave.*	Flavor score†	Color score	Per cent of breed ave.*	Flavor score†	Color score	Per cent of breed ave.*	Flavor score†
Mar. 2	5.7	45	2	8.4	85	1	10.3	105	1	11.8	153	1
" 21	13.0	105	1	9.5	93	1	9.5	93	2	9.4	122	1
Ration supplemented with a carotene concentrate Mar. 22												
Mar. 29	18.0	154	0	12.0	113	0	9.3	93	0	7.5	95	2
Apr. 4	14.7	124	0	11.9	112	0	27.8	262	0	10.1	150	0
" 20	17.0	145	0	10.2	96	1	.....	.....	...	8.7	148	0

* Breed average was obtained in each instance by averaging the color score for all individuals within the herd.

† A score of 0 to 5 was used to indicate the intensity of the oxidized flavor.

DISCUSSION

The prevalence of oxidized flavor in raw milk does not seem to be affected by the original amount of vitamin C in the milk or the amount of vitamin C lost during 3 days storage, Chilson (4) found that all the vitamin C was destroyed by the time oxidized flavor was detectable. In this trial, however, there were instances in which most of the vitamin C was left after 3 days storage, yet oxidized flavor had developed. Sharp, Trout, and Guthrie (9) found a definite relationship between the rate of disappearance of vitamin C during storage and the development of oxidized flavor when the milk was pasteurized at 143° F. for 30 minutes. Such a relationship may exist in pasteurized milk but it did not hold true for the data herein reported for raw milk.

From the review of the literature it seemed that lecithin was the substance oxidized when milk developed this off-flavor. Consequently it would appear that the amount of lecithin in the milk would influence the intensity and frequency of oxidation. In this trial, however, oxidized flavor occurred just as frequently in the milks of lower lecithin content as in the milks of the higher content. Thurston and co-workers (13) found that the physical state of lecithin in the milk, *i.e.*, whether it surrounds the fat globules or is dispersed in the plasma, was a contributing factor in causing oxidation. If lecithin is a cause of oxidized flavor it would seem that the physical or the chemical state is more important than the amount.

Results obtained in this trial seem to indicate that there is a relationship between breed and susceptibility of raw milk to becoming oxidized. Guthrie and Brueckner (6) and Dahle and Palmer (5) could find no relationship, but the results obtained by Stebnitz and Sommer (10) agree with the foregoing results. There was a significant difference when Holstein and Ayrshire breeds considered together were compared with the Jersey and Guernsey breeds, considered together. With the exception of the E-Holsteins oxidized flavor occurred in 15.8–19.4 per cent of 448 samples of Holstein and Ayrshire milk, whereas it occurred in only 6.1–7.8 per cent of 480 samples of Jersey and Guernsey milk.

Results of this experiment seem to indicate that high color intensity of the milk fat renders the milk less susceptible to the development of oxidized flavor. Since the Jersey and Guernsey breeds produced milk comparatively free from oxidized flavor, and since it is known that these breeds put more color into their milk than other breeds it might be expected that oxidized flavor would be less prevalent in highly colored milk. From observations made on milk from the entire herd, oxidized flavor occurred more frequently in the milk that was below breed average in fat color. With but four exceptions in 27 oxidized samples of milk all of the oxidized samples were below breed average in color intensity. Some exceptions might be expected in view of the many factors known to cause oxidized flavor.

Oxidized flavor seldom occurs during the seasons of the year when the cows are receiving plenty of green feed or a relatively high carotene intake from their ration. The susceptibility of raw milk from cows on winter rations to become oxidized can be eliminated by supplying a carotene supplement in the feed of the cow. A carotene concentrate supplying as little as 206 mgms. of carotene daily proved effective in preventing oxidized flavor in the milk of cows that had been consistently producing milk that became oxidized. When a lower amount of carotene was fed it decreased the intensity of oxidized flavor, but was insufficient to produce normal flavored milk. There was a decided increase in the fat color of the milk produced by cows receiving a carotene supplement indicating that the increased carotene was directly or indirectly responsible for obviating oxidized flavor.

It appears from the results in this experiment, that the problem of obviating oxidized flavor in raw milk is a matter of producing milk relatively non-susceptible to oxidation. This can be done by feeding a ration high in carotene throughout the year or by the use of supplements of carotene concentrates during winter months.

SUMMARY AND CONCLUSIONS

1. Oxidized flavor occurred in 11 per cent of 1,127 samples of milk.

2. No relation was found between the amount of vitamin C in the original milk, or between the amount of vitamin C lost during 3 days storage, and the development of oxidized flavor.

3. No relation was found between the frequency of occurrence of oxidized flavor and the lecithin content of the milk.

4. There appeared to be a relationship between color intensity of milk fat, as produced by different breeds and the development of oxidized flavor. Oxidized flavor occurred in 6.1–7.8 per cent, respectively, of 480 samples of Jersey and Guernsey milk and in 15.8–19.4 per cent, respectively of 448 samples of Holstein and Ayrshire milk.

5. Oxidized flavor was more prevalent in milks that were below breed average in fat color intensity.

6. The development of oxidized flavor in raw milk was effectively prevented by feeding as little as 206 mgms. of carotene per head daily to cows that had been consistently producing milk with this off-flavor.

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OXIDIZED FLAVOR IN MILK. VI. A STUDY OF THE RELATION OF TITRATABLE ACIDITY TO METAL-DEVELOPED OXIDIZED FLAVOR IN MILK[1]

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The development of oxidized flavor in high-quality milk has been one of the most harassing problems which confront the milk industry. Many investigators have spent much time seeking the cause and remedy of this off-flavor.

Recently Anderson, Dowd, and Stuewer (1) found that the titratable acidity of winter milk is higher than that of summer milk. This seasonal change is coincidental with the change in susceptibility to oxidized flavor. It seems possible that this condition may have been partially responsible for oxidized flavor. Anderson and his co-workers found an association between acidity and the tendency to develop this flavor. They were unable to eliminate the defect by giving a new coating of tin to all equipment not properly tinned or made of stainless steel. However, they were able to correct this defect by lowering the apparent acidity of the milk to 0.145 per cent in pasteurized milk. As a result of their work they concluded that this defect was associated with the apparent acidity of the milk and that milk of high acidity invariably developed an oxidized flavor upon pasteurization.

Whitfield, Davis, and Downs (2) have shown that low-acid milk develops an oxidized flavor when contaminated with copper. At the West Virginia Station, when an incidental check on the effect of neutralization of acidity on the development of oxidized flavor was made, the results were at such variance with those of Anderson and his co-workers that the following experiments were conducted.

EXPERIMENTAL

The milk used in these trials was produced by the West Virginia Experiment Station herd, which consisted of a mixture of animals of the Jersey, Guernsey, Holstein, and Ayrshire breeds. All milk used in these trials was produced on dry feed. In the experiments with individual cows' milk, the milk was drawn into aluminum pails, and a sample, taken by means of a glass beaker, was transferred directly to a glass bottle. After all the samples were collected they were brought immediately to the laboratory, where the acidity was determined by titrating 17.5 ml. of milk with N/10 NaOH by use of 3 to 5 drops of phenolphthalein as an indicator; the results were

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[2] Department of Dairy Husbandry.
[3] Department of Agricultural Chemistry.

expressed in terms of per cent lactic acid. At no time did more than two hours elapse between the time the samples were drawn and the time the acidity determinations were made.

Following the determination of acidity all the samples were pasteurized by heating in the glass bottles to 144° F. ± 1° for 30 minutes followed by cooling to 60° F.

After cooling, each sample was divided into two parts; one part served as a control while the other was contaminated with 1.3 p.p.m. of copper added from a copper sulphate solution, this procedure having already been shown to develop oxidized flavor in susceptible milk. Both samples were then placed in ice water and allowed to remain there for three days, when they were removed and scored for flavor by at least three judges familiar with the off-flavor. All scoring was done without knowledge of the acidity of the milk as originally drawn.

The results of a study of 220 individual cows' samples are shown in Figure 1. An examination of the "line of least squares" shows that no rela-

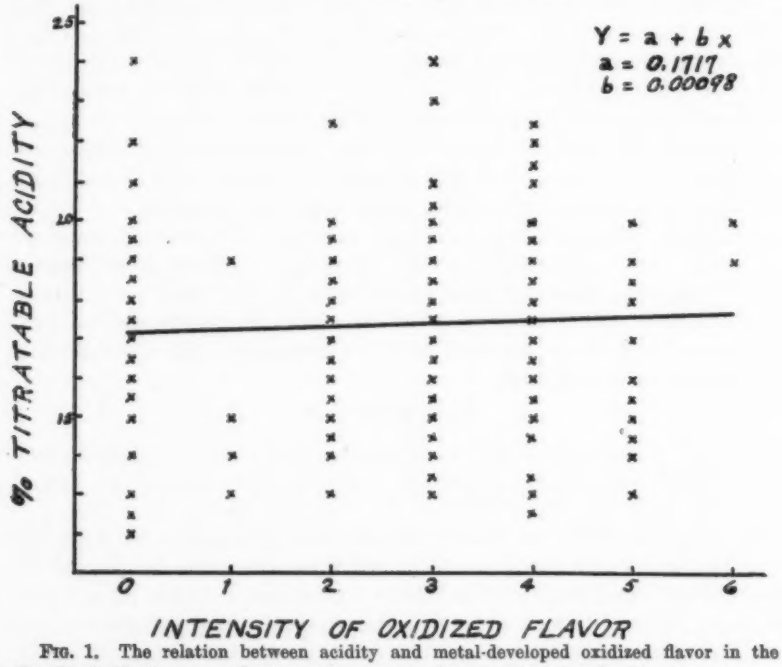

FIG. 1. The relation between acidity and metal-developed oxidized flavor in the milk of individual cows. (Each cross represents from 1 to 8 determinations.)

tion exists between the acidity of freshly-drawn milk and the tendency to develop oxidized flavor. Both normal and oxidized-flavored milk was found in the low- and the high-acid milks in roughly the same proportion.

In the determination of oxidized flavor in individual cows' samples, three cases of spontaneously developed oxidized flavor occurred.

From the results, shown in Table 1, it would appear that there is a negative correlation between the acidity and the intensity of oxidized flavor, but because of the small number of observations no conclusions can be drawn.

TABLE 1

Relationship between acidity and spontaneous oxidized flavor development

Cow No.	Titratable acidity	Intensity of oxidized flavor*
	Per cent	
524	0.205	1
347	0.190	2
529	0.150	3

* For meaning of symbols see Table 2, footnote.

Since there was apparently no correlation between the acidity of freshly-drawn milk and the intensity of metal-developed oxidized flavor, it seemed advisable to determine whether or not neutralization had any effect on the tendency to develop the flavor.

STANDARDIZATION OF ACIDITY

In the standardization of acidity, the acidity of the milk was determined after the raw milk had been placed in the vat. A concentrated solution of neutralizer was used to neutralize the natural acidity of the milk. The neu-

TABLE 2

The development of oxidized flavor in unneutralized milk

Date	Source of sample			
	Raw milk	Pasteurized milk		
	In vat	In vat	End of the line—first over equipment	End of the line—taken when vat ⅓ full
	Intensity of oxidized flavor*			
2/17/38	3	4	4	4
2/21/38	3	4	4	4
2/25/38	3	4	4	4
3/ 1/38	3	3	3	missed
3/ 6/38	3	4	3	3
3/12/38	3	4	4	3
3/19/38	3	3	3	3
3/20/38	2	4	4	4
3/26/38	4	4	4	4

* Flavor developed by the addition of 1.3 p.p.m. copper. Control samples all free from oxidized flavor.

Meaning of symbols: –, no oxidized flavor; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor.

tralizer was added, just before pasteurization, when the milk was at a temperature of from 80 to 90° F. The milk was held at this temperature for 10 to 15 minutes. The final acidity was checked in the milk after it had passed over the equipment. "Neutralene," C.P., Na_2CO_3, and $NaHCO_3$ were used to reduce the acidity. No difference in flavor was found due to differences in neutralizers.

The intensities of the oxidized flavor developed in unneutralized milk are given in Table 2. This flavor was developed by the addition of 1.3 p.p.m. of copper added from a copper sulphate solution followed by storage for three days in ice water. The control samples, to which no copper was added, did not develop an oxidized flavor, and these results were omitted from the table. The acidity was not determined on the samples reported in Table 2, but as all this milk was from one source, the acidity probably varied between 0.16 and 0.18 per cent. All samples that were contaminated with copper developed an oxidized flavor. As was to be expected from previous experimental work, the pasteurized milk developed a slightly stronger oxidized flavor.

The effects of neutralization on the intensity of oxidized-flavor development are shown in Table 3.

TABLE 3

The development of oxidized flavor in neutralized milk

Date	Per cent acid		Source of sample			
			Raw milk	Pasteurized milk		
	Original	Final	In vat	In vat	End of line—first over equipment	End of line—taken when vat ¼ full
			Intensity of oxidized flavor*			
3/14/38	0.170	0.150	3	4	3	3
3/15/38	0.165	0.130	3	4	4	3
3/16/38	0.165	0.140	3	4	3	3
3/17/38	0.165	0.140	3	4	4	4
3/18/38	0.165	0.140	3	4	4	4
3/21/38	0.165	0.145	4	4	4	3
3/22/38	0.175	0.140	4	4	4	3
3/23/38	0.175	0.100	4	4	4	3
3/24/38	0.180	0.110	4	4	3	3
3/25/38	0.175	0.130	4	4	4	missed
3/27/38	0.175	0.095	4	4	4	3
3/28/38	0.175	0.135	4	4	4	missed
3/29/38	0.170	0.125	4	4	4	4
3/30/38	0.175	0.125	4	5	4	missed
3/31/38	0.180	0.125	3	4	4	4
4/ 1/38	0.170	0.160	4	4	4	4
4/ 2/38	0.180	0.140	4	4	4	3

Samples 3/14 to 3/23/38—neutralized with neutralene.
3/24 to 3/29/38—neutralized with Na_2CO_3.
3/30 to 3/31/38—neutralized with neutralene.
4/ 1 to 4/ 2/38—neutralized with $NaHCO_3$.

* For meaning of symbols see Table 2, footnote.

Analysis of these results shows that standardization of the acidity of milk to 0.13 per cent did not affect the tendency for the milk to develop oxidized flavor when that milk was contaminated with copper. In the two cases in which the milk was neutralized to 0.10 and 0.095 per cent, respectively, the tendency for oxidized flavor to develop was unchanged. In all cases in which the neutralization carried the acidity below 0.13 per cent there was a noticeable neutralizer flavor, but the oxidized flavor could easily be noticed above this. These results show definitely that neutralization does not affect the tendency for oxidized flavor to develop.

DISCUSSION OF RESULTS

No explanation is offered for the discrepancy in results which have occurred except that possibly the milk used by Anderson and his co-workers was subject to the development of oxidized flavor without copper contamination while the milk used in these trials would not develop oxidized flavor unless contaminated with copper. In all trials herein reported the copper was added after pasteurization in the form of a copper sulphate solution. In view of this fact it would have been desirable to make several trials upon naturally susceptible milk, but during the past two years milk of this type has not been available, except in rare cases, in the University herd.

In the few cases in which oxidized flavor developed spontaneously no direct relation was apparent between acidity and the intensity of the oxidized flavor developed.

Probably the chief reason for the belief that oxidized flavor might be related to the acidity is the fact that summer milk, which is usually non-susceptible to oxidized flavor, is generally lower in acidity than is winter milk which, when produced on dry feed, is usually susceptible to oxidized flavor if contaminated with copper.

CONCLUSIONS

1. There does not appear to be any relationship between the acidity of freshly-drawn milk and the intensity of metal-developed oxidized flavor.

2. Standardization of the acidity of fresh milk to 0.13 per cent did not prevent the development of oxidized flavor when copper is added after pasteurization.

ACKNOWLEDGMENT

The authors wish to express their appreciation for the assistance of Mr. L. J. Manus, Instructor in Dairy Husbandry, and Mr. L. V. Menefee, University creamery superintendent, in determining the flavor of experimental samples.

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A RAPID METHOD FOR DETERMINING MOISTURE IN ROUGHAGES

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In operations where moisture control is necessary it is of prime importance to be able to determine the moisture content of the material quickly. The usual oven-drying methods which take from 12 to 24 hours are too slow to be of great help in such cases. A rapid yet reasonably accurate method of determining moisture can be of the greatest value in establishing experimentally the conditions most desirable for storing hay and silages of various kinds. Such a method would likewise seem to offer great possibilities in the control of these operations under practical farm conditions, thus assuring uniformly better results.

While seeking for a quick, simple method for determining moisture in roughages it was discovered that there was on the market an apparatus[1] designed for the rapid determination of moisture in controlling certain manufacturing processes. This seemed to offer possibilities for use in drying grass and hay samples. The rapid removal of moisture is accomplished in this machine by forcing heated air through the sample. Essentially the apparatus consists of an electric fan and heating element encased in a tube which is enlarged at the base. A removable pan containing the sample to be dried is held snugly against the base by means of a spring clamp. The bottoms of the sample pans are specially constructed of 500-mesh screening to permit the passage of air. The complete apparatus including the necessary balances, drier, and utensils is shown in the accompanying illustration (Fig. 1).

In order to check the accuracy of the results obtained by the machine-drying, some samples have been dried by this process and also by the usual oven method. In Table 1 some of the results of this comparison are shown. In the oven-drying process the samples were allowed to remain in an electric oven for approximately 24 hours; the temperature was regulated to 100° C. After removal from the oven the samples were cooled to room temperature in a desiccator before weighing.

For the machine-drying process the time of drying ranged from 10 to 30 minutes, as shown in the table. The finer samples of grass required less time than corn silage containing some coarser particles. It was found desirable to stir the sample gently at approximately the middle of the drying process. After the pans were removed from the drier they were allowed to cool to room temperature in the open before weighing. All samples were weighed on a

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[1] Manufactured and sold by Harry W. Dietert Co., 9330 Roselawn Avenue, Detroit, Michigan.

balance with a sensitivity of 20 milligrams. Green material dried in this apparatus retained its original color remarkably well, although the temperature of the air forced through the material ranged from 105 to 115° C.

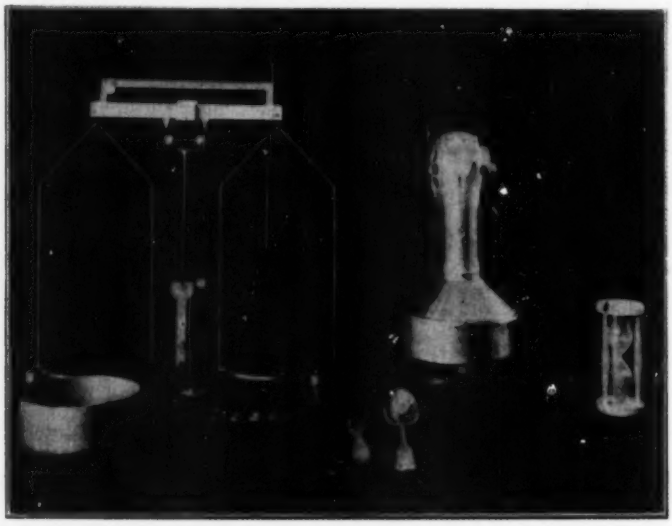

FIG. 1. Apparatus used in the rapid determination of moisture in roughages. Left rear—Balances, sensitivity 20 milligrams. Right rear—Drying machine with sample pan in position. Foreground—(left to right) Sample pan, weights, tongs, brush, spoon, and 10-minute time-glass.

TABLE 1

Comparison of results of dry-matter determinations by machine-drying and by the usual oven method
(Determinations made in triplicate)

Sample	Weight of wet sample	Time of drying in machine	Dry matter	
			Machine dried	Oven dried
	Grams	*Minutes*	*Per cent*	*Per cent*
Corn silage (whole)	20	30	26.35	25.9
Corn silage (whole)	20	30	25.2	25.4
Corn silage (whole)	50	30	29.3	28.1
Average			26.95	26.47
Green rye	20	10	15.3	15.0
Bluegrass	20	10	24.5	24.0
Bluegrass	20	10	27.0	26.75
Bluegrass	20	10	21.7	20.41
Average			24.4	23.72
Red clover	20	15	23.7	24.2
Alfalfa hay	20	10	89.5	89.5

In most cases 20-gram samples were used, although it is possible to use somewhat larger samples for some materials. The time required for drying did not seem to be so much influenced by the size of the sample as by the coarseness of the material. The materials used were cut into lengths ranging from 1 to 2 inches for convenience in sampling and weighing. Corn silage was sampled without further chopping. The thick stalks in the silage necessitated a longer drying period.

A fairly close agreement was found between the results obtained by the two methods. When proper consideration is given to the possibility of sampling errors, the small samples used, and the rather crude system of weighing, the agreement is probably all that could be expected. For most control work the results obtained by the machine drier are sufficiently accurate to justify its use. In fact, with additional refinements this process of machine drying may even be suitable for some kinds of laboratory work. The samples dried in the machine showed less discoloration, an evidence of deterioration, than did those dried in the oven for 24 hours at 100° C.

SUMMARY

Moisture was determined in the same samples of roughage by 1, drying in an electric oven for 24 hours at 100° C.; 2, drying 10 to 30 minutes in a machine designed to force heated air through the material. The results obtained by the two methods showed a satisfactory agreement.

THE CALCULATION OF FAT CORRECTED MILK BY MEANS OF A NOMOGRAPH CHART

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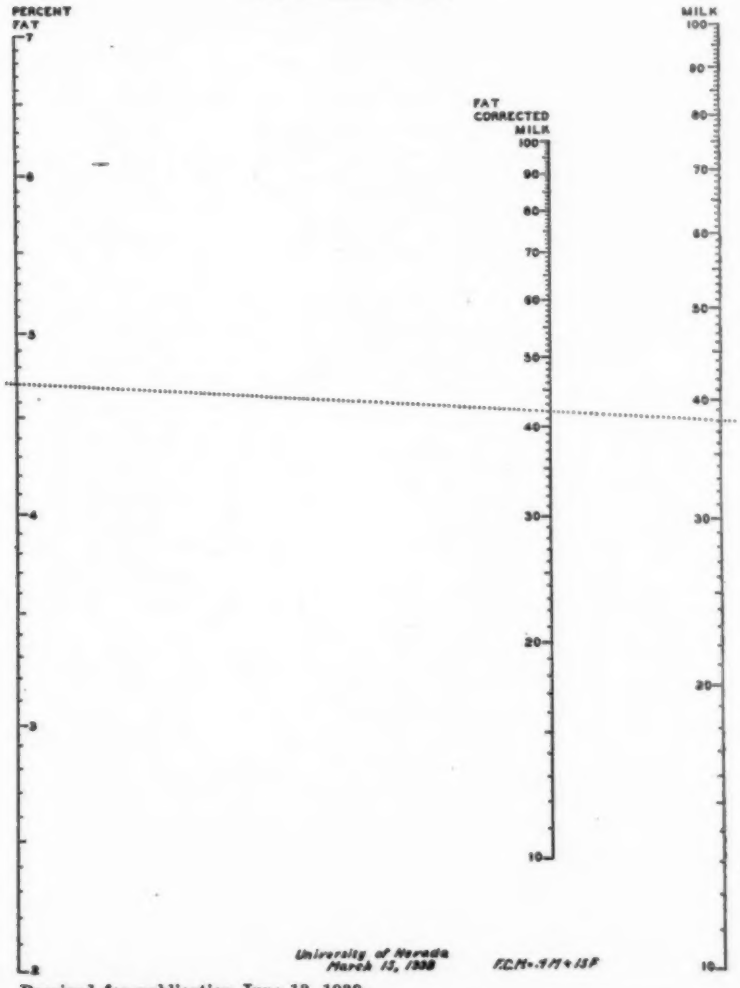
It has recently been pointed out by A. E. Perkins[1] that the reduction of weights of milk of varying fat content to a uniform fat-corrected basis has a



Received for publication June 13, 1938.

[1] Perkins, A. E. A Simplified Procedure for Calculating Weights of Milk to Their Energy Equivalent in Milk of Different Fat Content in Accordance with the Gaines Formula. Jour. Dairy Sci. 20: 129–132. 1937.

number of advantages. It is, therefore, not necessary to discuss again the uses which may be made of this procedure.

Gaines formula for making this correction is as follows:

$$FCM = 0.4M + 15F$$

in which FCM = weight of fat corrected milk, M = weight of milk and F = weight of fat. The weight of the fat is obtained by multiplying the weight of the milk by the percentage of fat.

Professor Perkins has shown that the time required to make calculations may be considerably shortened by multiplying the pounds of milk by a factor which is dependent on the percentage of fat in the milk.

The problem may also be quickly solved without any mathematical computation by using the accompanying nomograph chart. Problems are solved by laying a ruler, or other straight edge, from the pounds of milk in the right-hand scale to the percentage of fat in the left-hand scale and reading the answer in the center scale.

For example: Find the FCM in 38 pounds of milk testing 4.7 per cent fat.

Solution: Lay a straight edge from 38 in the right-hand scale to 47 in the left-hand scale and read the answer 42 pounds, in the center scale, as indicated by the dotted line.

THE RELATION OF THE QUALITY OF MILK TO THE GRADE OF SWISS CHEESE[1]

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While it is generally conceded that good milk, from a bacteriological standpoint, is essential for making a high grade cheese of any variety, and particularly of the Swiss type, there is little definite information to support this contention. Donner and Ritter (1), compiling records on 42 cheeses made in Switzerland, found that the proportion of first grade cheese was at its maximum when the milk reduced methylene blue in 3 to 4 hours. There was a sharp decrease in the proportion of first grade cheese when the reduction time was less than 3 hours.

During the past 2 years the Bureau's portable field laboratories, operating in the Swiss-cheese district of Ohio in cooperation with the Ohio State University and in Wisconsin in cooperation with the University of Wisconsin, have accumulated records that warrant drawing certain conclusions. Since the cheeses on which these records were obtained were the regular factory product, without the checks and controls essential in properly conducted experimental manufacture, it is necessary to consider the data statistically. Obviously, it is safe to draw conclusions from statistical evidence only if the volume of data is sufficient and the sampling is representative. The data under consideration was obtained from slightly more than 500 cheeses made in a period of 2 years in 20 factories in Wisconsin and Ohio. While the number of cheeses in some of the groups is too small to justify any but tentative conclusions, the trends in the large groups are definite and consistent. There is some basis for criticism in the fact that these laboratories worked more with the factories having manufacturing difficulties than with those normally making good cheese. However, the factories from which these data were obtained are fairly representative and include some of the best in each state.

The quality of the milk was determined by a methylene blue reduction test made by a standardized method on the kettle milk. Samples were taken before adding starters or rennet.

In tabulating the quality of the cheese the grades established by the buyers

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[1] Since this paper was written an abstract of a paper on this subject has appeared: Erekson, A. B., Eckburg, C. A., and Lee, E. Methylene blue reduction time as an indication of the suitability of milk for the manufacture of Swiss cheese. JOUR. DAIRY SCI. 21: 172, 1938. The conclusions, based on records of 2,463 cheeses, are in substantial agreement with those presented in this paper.

TABLE 1

Relation of methylene blue reduction time to grade of cheese
Wisconsin and Ohio cheese 1936–1937

Reduction time	Total No.	A		B		C		D		A + B		C + D	
		No	%	No.	%	No.	%	No.	%	No.	%	No.	%
Not over 2 hrs.	80	12	15.00	17	21.25	30	37.50	21	26.25	29	36.25	51	63.75
Over 2 hrs., not over 3 hrs.	112	10	8.93	22	19.64	51	45.54	29	25.89	32	28.57	80	71.43
Over 3 hrs., not over 4 hrs.	119	18	15.13	49	41.18	40	33.61	12	10.08	67	56.30	52	43.70
Over 4 hrs., not over 5 hrs.	138	30	21.74	63	45.65	30	21.74	15	10.87	93	67.39	45	32.61
Over 5 hrs.	56	21	37.50	18	32.14	8	14.29	9	16.07	39	69.64	17	30.36

were used. It is recognized that this is by no means an exact measure of cheese quality, but it is the criterion on which the cheeses were sold and is the only one available.

In these tabulations the cheese grades are designated as A, B, C, and D, corresponding to the usual commercial grades. In Ohio these grades are known as No. 1, Special, No. 2, and Grinder; in Wisconsin the corresponding grades are designated as Fancy A, Fancy B, Fancy C, and Grinder. C and D may be considered as undergrades.

Table 1 shows the relationship between the reduction time and the percentage of cheese in each grade. While the correlation between the methylene blue reduction time and the grade is not entirely consistent there is a very distinct tendency for the grade to become better as the reduction time increases. This table also indicates that there is a distinct increase in the proportion of the two better grades when the reduction time passes 3 hours. This is shown more strikingly in Figure 1, in which the cheeses are divided into two groups, one including all cheeses made from milk in which the reduction time was not over 3 hours and the other, including all cheeses made from milk which required more than 3 hours for reduction. All cheeses in the A and B grades are combined in column 1 and those in the undergrades C and D in column 2. When the reduction time was 3 hours or less there were more than twice as many cheeses in the undergrades as in the A and B grades; when the reduction time was over 3 hours the results were reversed, with nearly twice as many in the A and B grades as in the undergrades.

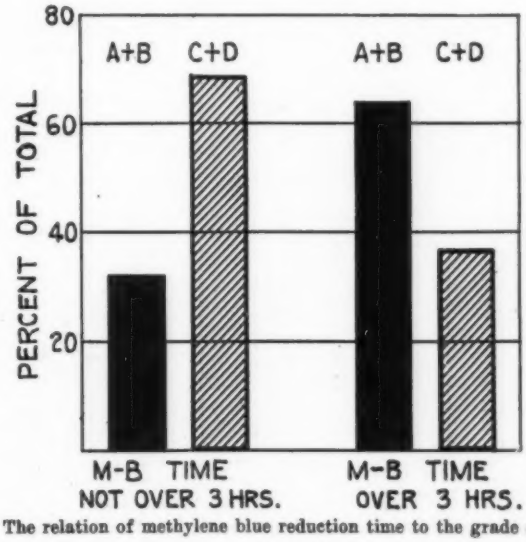

FIG. 1. The relation of methylene blue reduction time to the grade of the cheese.

While it is very evident that there is a direct relation between the quality of the milk as indicated by the methylene blue reduction time and the grade of the cheese, the bacteriological reason for this correlation is not so clear. Frazier (2) has shown that when bacteria of the aerogenes type are present in large numbers they multiply in the kettle and even if they are completely suppressed by the lactic bacteria they have a distinctly unfavorable effect on the quality of the cheese. It has also been observed that some of the spore-forming bacteria occurring in poor milk may develop in the cheese during the ripening and cause off-flavors and abnormal eye formation.

These conditions may occur when the bacteriological condition of the milk is unsatisfactory and they may account for at least a part of the inferior quality of the cheese.

There is also evidence of a correlation between the bacteriological condition of the milk and the rate of acid development during the making process. Under what may be termed normal conditions there is a small increase in the acidity of the milk in the kettle, represented by a drop in pH from about 6.6 in the fresh milk to from 6.5 to 6.4 at dipping. If the milk is well inoculated with acid forming bacteria and these are reinforced by an active starter, the pH change is more rapid and to a lower level.

The relation of this difference in acid development to the quality of the cheese is shown in Figure 2. The first four columns show the relative proportion of first and second grade cheese made from milk that reduced methylene blue in 3 hours or less. The solid columns represent A and B grades and the undergrades are shown by hatched columns. There was practically no difference in the proportion of first and second grade cheese when the pH at dipping was below 6.36 and when it was between 6.36 and 6.51. In other

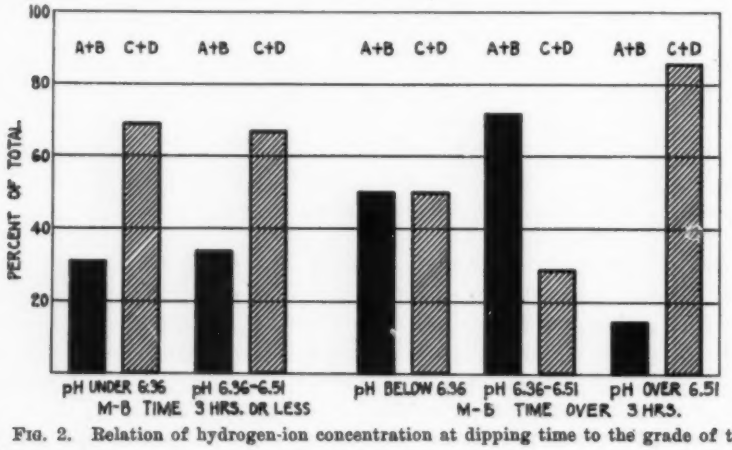

FIG. 2. Relation of hydrogen-ion concentration at dipping time to the grade of the cheese.

words, if the milk is so poor that it reduces methylene blue in 3 hours or less, the chances are about one in three that the cheese will be first grade and this ratio is not likely to be changed appreciably by differences in the rate of acid formation in the kettle.

The 6 columns on the right show the distribution of grades of cheese made from milk reducing methylene blue in more than 3 hours.

If the cheese is made from milk that has a reduction time greater than 3 hours and the pH at dipping is less than 6.36, the chances are even that the cheese will be in the A or B grade. If, however, the pH at dipping is between 6.36 and 6.51 the chances are three in four that the cheese will be A or B grade. If the bacteriological conditions in the milk are such that there is very little development of acid in the kettle and the pH at dipping is above 6.51, it is highly probable that the cheese will be undergrade. These results indicate that the chances of obtaining an A or B grade cheese are only a little better than 1 in 10, but this is based on a small number of cheeses and is only tentative. However, it confirms the generally accepted belief of the cheesemakers that milk which works slowly, so-called "dead" milk, is not suitable for Swiss-cheese making.

CONCLUSIONS

One of the most important factors influencing the quality of Swiss cheese is the bacteriological condition of the milk. This can be determined satisfactorily for manufacturing purposes by the methylene blue reduction test. If the methylene blue reduction time on the kettle milk is not over 3 hours the chances are about one in three that the resulting cheese will be of the A or B (No. I or Special) grade. If the reduction time is over 3 hours, 2 out of 3 cheeses may be expected to be of the A or B grade.

The chances of making an A or B grade cheese may be increased to three out of four, by adjusting the starters and making process to secure a pH at dipping above 6.35 and not over 6.51. If the pH at this time is over 6.51 there is only 1 chance in 8 or 10 that the cheese will be of the A or B grade.

It does not necessarily follow that the rapid increase in acidity indicated by a pH of 6.35 or lower at dipping time is in itself responsible for the inferior quality of the cheese which frequently results when these conditions exist. The conditions which produce a rapid development of acid may also promote the growth of abnormal bacteria having an unfavorable effect on the curd. Some of the increase in acidity may be due to ordinary lactic streptococci, which have an opportunity to grow for a short time in the early stages of the making process, and when the bacterial content of the milk is high other bacteria may develop until they are checked by the high temperature of cooking. It has been pointed out that certain of these bacteria may have a deleterious effect even though their activity in the kettle is limited.

It is highly probable, however, that when the pH at dipping goes as low

as 6.30 or even 6.20, as it frequently does under factory conditions, it is due to an active thermophilic coccus which develops even during the cooking process and that the defective cheese may be attributed directly to the abnormally high acidity.

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LIVE WEIGHT AND MILK–ENERGY YIELD IN THE WISCONSIN DAIRY COW COMPETITION

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The Wisconsin Dairy Cow Competition was conducted during the years 1909–1911 and the records were published in some detail by Woll (1). Brody and Cunningham (2) recently utilized Woll's data to show that gross efficiency is independent of live weight. The object of the present paper is to extend their observaton to show that, in these records, milk-energy yield per unit live weight is independent of live weight. As will be developed, these two relations permit the deduction that the digestible feed energy of working maintenance is proportional to live weight (rather than a fractional power of live weight). The utilization of live weight and milk-energy yield per unit live weight in a philosophy of dairy cattle breeding will be mentioned.

LIVE WEIGHT AND GROSS EFFICIENCY

Gross efficiency is defined as the percentage ratio of milk-energy yield to digestible feed energy consumed. What is the relation of this ratio to live weight as shown by Woll's data?

Milk-energy yield is estimated from the reported milk and fat yields in terms of pounds of 4-per-cent milk (FCM) by the .4M + 15F formula. Feed consumption is reported by Woll in terms of feed units (FU), one FU being the equivalent of one pound of corn. Live weight in pounds (W) is given for 369 cows. FCM, FCM/FU and FCM/W have been computed for each of the 369 cows. For present purposes we are not concerned with the absolute values of gross efficiency but only its relation to live weight, which is equally well shown by FCM/FU.

The correlation surface for W and FCM/FU is shown graphically in Figure 1, and gives $r = +.345 \pm .032$. This result seems to contradict the statement that gross efficiency is independent of live weight. However, Woll allows 8 FU per day on pasture for each cow regardless of her live weight, although he states, "the number of units at which pasture should be rated will vary greatly according to its quality and the production and live weight of the cows and may range between 4 and 12 units per day." Qualitatively, correction of this rather serious error in the estimate of feed consumption would reduce, algebraically, the above value of r; quantitatively, it is quite possible it might reduce r to zero. We may accept provisionally the conclusion of Brody and Cunningham that, in these records, gross efficiency is independent of live weight.

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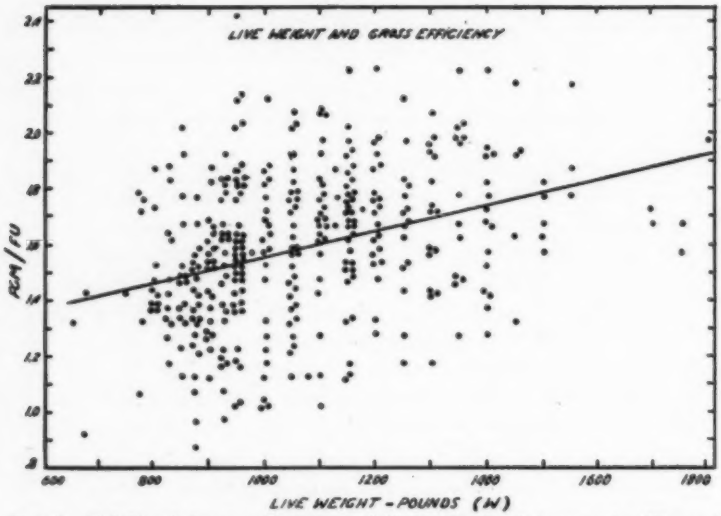

FIG. 1. Relation between milk-energy yield in pounds of 4-per-cent milk per feed unit consumed (FCM/FU) and live weight in pounds (W). The regression, shown by the straight line, is FCM/FU = 1.096 + .000465W. Gross efficiency (100 × milk calories/digestible feed calories) = 23.73(FCM/FU), computed as milk calories = 340FCM and digestible feed calories = 1433FU.

LIVE WEIGHT AND MILK-ENERGY YIELD PER UNIT LIVE WEIGHT

The correlation surface for W and FCM/W is shown graphically in Figure 2, and gives $r = -.023 \pm .035$. It is clear that live weight and milk-

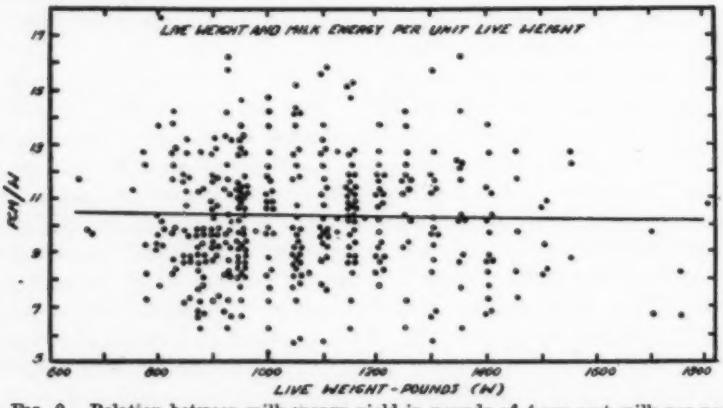

FIG. 2. Relation between milk-energy yield in pounds of 4-per-cent milk per pound live weight (FCM/W) and live weight in pounds (W). The regression, shown by the straight line, is FCM/W = 10.531 − .000256W.

energy yield per unit live weight fluctuate independently of each other. Or, milk-energy yield tends to be a multiple of live weight.

LIVE WEIGHT AND WORKING MAINTENANCE

We may split feed consumed, FU, into two parts: feed for lactation, FU′; and feed for working maintenance, FU″; such that FU = FU′ + FU″. We may assume FU′ is proportional to FCM, and hence proportional to W, in these records. If FCM/FU is constant so far as related to W (gross efficiency independent of live weight) and FCM is proportional to W, it follows that FU is proportional to W, and FU″, the feed for working maintenance, must also be proportional to W.

While it is recognized the reported feed consumption of individual cows is erroneous with respect to pasture, this would not warrant the deductions made except for the support of other findings (3, 4).

DISCUSSION

Under rules of the Competition entry was open to cows of any breed and records might start with the fifth or any later day after calving and continue not to exceed 365 days during the same lactation. Grade and registered cows of the Jersey, Guernsey, and Holstein breeds were entered. The latest stage of lactation of any entry was 637 days after calving (No. 322, days in milk = 314, FCM = 9999.9). The shortest time in milk was 269 days (No. 295). It is obvious that such variation in days in milk and stage of lactation must have an effect on both yield and gross efficiency. In Table 1 correlations are given for subgroups by days in milk and by breed of cow.

It will be noted in Table 1 that while for all breeds together W and FCM/W are independent, the same is not strictly true within any one of the breeds. This difference is associated with the fact that FCM/W is lowest for the smallest breed, and highest for the largest breed, thus:

Breed	365-day records		Other records	
	mean W	mean FCM/W	mean W	mean FCM/W
Jersey	930	10.125	903	8.899
Guernsey	997	10.514	974	9.534
Holstein	1272	11.346	1202	10.830

It is quite unexpected to find such a condition, and it may be that as a breed the Holsteins had more nearly optimum conditions for maximum production than did the Jerseys, with the Guernseys intermediate. However that may be, the results emphasize the necessity of taking size of cow into account in a breeding philosophy (*cf.* 5, 6).

TABLE 1

Coefficients of correlation (r) between live weight (W) and milk-energy yield per unit live weight (FCM/W), and between live weight (W) and milk-energy yield per feed unit (FCM/FU) by length of record and by breed of cow

Breed	Item	365-day records*	Other records	All records
Jersey	r, W and FCM/W	−.59	−.22	−.27
	r, W and FCM/FU	−.08	+.31	+.25
	number of cows	17	59	76
Guernsey	r, W and FCM/W	−.47	−.12	−.22
	r, W and FCM/FU	−.13	+.28	+.12
	number of cows	68	76	144
Holstein	r, W and FCM/W	−.23	−.64	−.45
	r, W and FCM/FU	+.20	+.15	+.22
	number of cows	67	82	149
All Breeds	r, W and FCM/W	−.06	−.06	−.02
	r, W and FCM/FU	+.31	+.32	+.35
	number of cows	152	217	369

* Records starting within 30 days after calving and continuing 365 days in milk. An important point, on the side, in the 365-day records of all breeds together is the relation of age to yield. Dealing with cows under 6 years of age (106 cows, ages 1.79 to 5.90 years) to approximate linear regression of yield on age, the correlation between age and FCM is, $r = +.30$, and $FCM = 8998 + 762 \times age$; between age and FCM/W, $r = +.14$ and $1000FCM/W = 9742 + 234 \times age$. Most of the age trend is removed in FCM/W and use of initial live weight for W would practically remove the age trend completely. That is, FCM/W needs no "age corrections."

DAIRY CATTLE BREEDING PHILOSOPHY

1. Breed for size of cow, that is, set up size as a first characteristic. We can breed cows of any size from say 700 pounds to 1500 pounds with some degree of certainty. Some dairymen need large cows, others need small cows. This need can be directly met.

2. Breed for composition of milk, that is, set up milk composition as a second characteristic. Fat percentage may be a satisfactory measure of composition. We can breed for milk of any fat percentage from say 3 to 6 with some degree of certainty. Some dairymen need cows giving milk of high fat percentage, others, low fat percentage. This need can be directly met.

3. Breed for hard-working cows, that is, set up degree of work in lactation as a third characteristic. Milk-energy yield per unit live weight may serve as a measure of degree of work. All dairymen need cows with high development in this regard. It is the most important to have, and least certain to breed for, of the three characteristics.

The point of view is that the inheritance of milk production in the dairy cow goes back to having an organism strong enough to do the work, accomplish the energy transformations, directly and indirectly connected with heavy long-time milk giving. Size of itself is thus a primary consideration. Knowing the size of the organism, the next consideration is to measure its

proclivity to milk secretion, to obtain quantitative data for genetic study of this phase. Obviously, absolute milk yield is not directly suitable. Milk-energy yield per unit live weight may be directly suitable. Appropriate units need to be chosen and appropriate environment provided.

The above point of view attempts to distinguish between high yield associated with large size of cow and high yield at a given size of cow. If we breed larger cows and secure higher yields, it may be that we have progressed only in the first characteristic (size) and not at all in the most important third characteristic (degree of work, or proclivity to lactation). It is necessary to distinguish between these two phases of development in the dairy cow.

SUMMARY

Records of 369 cows (Jersey, Guernsey, Holstein—grade or registered) show that milk-energy yield per unit live weight is independent of live weight ($r=-.023$). The same records show that gross efficiency (milk energy/feed energy) increases with live weight ($r=+.345$). Elimination of recognized systematic errors in the feed record may reduce the latter correlation to zero, making gross efficiency, in fact, independent of live weight. Then, a permissible deduction is that the feed of working maintenance is proportional to live weight.

In study of the genetics of milk yield in dairy cows, distinction should be made as to size of the organism which may be measured by live weight, and proclivity to lactation which may be measured by milk-energy yield per unit live weight.

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REPORT OF THE STUDENTS NATIONAL JUDGING CONTESTS

THE STUDENTS NATIONAL CONTEST IN JUDGING DAIRY CATTLE

Twenty-six teams competed in the Collegiate Dairy Cattle Judging Contest held in connection with the National Dairy Show at Columbus, Ohio, October 8, 1938. The rules under which the contest was conducted were the same as those used in 1937. Fifteen rings of animals, three rings from each of the five breeds, were judged and oral reasons were graded on one ring of cows from each breed.

The official Judges for each breed were:

Ayrshires: Jack Nisbet, Fort Atkinson, Wisconsin.

Brown Swiss: Fordyce Ely, University of Kentucky, Lexington, Ky.

Jerseys: Frank Astroth, South St. Paul, Minn.

Guernseys: O. G. Schaefer, Graybar Bldg., New York, N. Y.

Holsteins: L. S. Gillette, Fostoria, Iowa.

The results of the contest were announced at an American Dairy Science Association banquet in Pomerene Hall on the Ohio State University campus.

Teams from the following colleges and universities were represented and are listed in the order of their rank in judging all breeds.

1. Ontario Agricultural College
2. Iowa State College
3. University of Minnesota
4. South Dakota State College
5. Ohio State University
6. University of Missouri
7. Pennsylvania State College
8. University of New Hampshire
9. Purdue University
10. Texas Technological College
11. University of Tennessee
12. University of Wisconsin
13. University of Illinois
14. University of Arizona
15. Texas A. & M. College
16. Cornell University
17. Kansas State College
18. University of Georgia
19. Michigan State College
20. New Mexico College of A. & M.
21. Mississippi State College
22. Oklahoma A. & M. College
23. Rutgers University
24. Virginia Polytechnic Institute
25. Connecticut State College
26. University of Nebraska

FIVE HIGH RANKING INDIVIDUALS IN JUDGING ALL BREEDS

1st. Vincent Kelly, Iowa State College
2nd. P. Archibald, Ontario Agricultural College
3rd. Ira Crawford, University of Missouri
4th. L. H. Schultz, University of Wisconsin
5th. Merrill Siglin, South Dakota State College

DONORS OF AWARDS FOR PROFICIENCY IN JUDGING WERE:

American Jersey Cattle Club.

$400.00 Research Scholarship, awarded to R. F. Schroeder, University of Wisconsin, High ranking individual in judging Jersey cattle. Also a plaque awarded to R. F. Schroeder.

Rotating Jersey Model, awarded to the Ontario Agricultural College, high ranking team in judging Jerseys. Also plaques to each member, coach and alternate of the Ontario team.

Ayrshire Breeders' Assn. of America.

A silver cup, awarded to C. F. McKenney, Virginia Polytechnic Institute, High ranking individual in judging Ayrshire cattle.
A rotating silver cup, awarded to the University of Georgia, high ranking team in judging Ayrshires. Also a silver plaque was awarded to the Georgia team.
A silver cup was awarded to each member and alternate of the Georgia team.

Brown Swiss Breeders' Assn.

An imported Brown Swiss Cow Bell, awarded to Stewart Sewell, Texas Technological College, high ranking individual in judging Brown Swiss cattle.
Pen desk sets, awarded to each member, alternate, and coach of the Purdue University team, high ranking team in judging Brown Swiss cattle.

American Guernsey Cattle Club.

Guernsey silver milk jug and sugar bowl, awarded to Joe Baxter, University of Tennessee, high ranking individual in judging Guernsey cattle.
A rotating Large Milk Can, awarded to the University of Minnesota, high ranking team in judging Guernseys. Also, a Guernsey silver milk jug and sugar bowl was awarded to each member, coach, and alternate of the Minnesota team.

Holstein-Friesian Assn. of America.

Gold Medal, awarded to R. Bagg, Ontario Agricultural College, high ranking individual in judging Holstein cattle.
Rotating cup, awarded to the Ontario Agricultural College, high ranking team in judging Holsteins.
Gold Medals, awarded to each member and alternate of the Ontario team.
Brief case, awarded to G. E. Raithby, coach of the Ontario team.

National Dairy Show.

Gold Medal, awarded to Vincent Kelly, Iowa State College, high ranking individual in judging All Breeds.
Silver Medal, awarded to P. Archibald, Ontario Agricultural College, second high ranking individual in judging All Breeds.
Bronze Medal, awarded to Ira Crawford, University of Missouri, third high ranking individual in judging All Breeds.
Rotating cup, awarded to the Ontario Agricultural College, high ranking team in judging All Breeds.

Successful Farming.

Successful Farming Canes to the three high ranking men in judging All Breeds (Vincent Kelly, 1st; P. Archibald, 2nd; and Ira Crawford, 3rd.)

J. B. Ford Company.

Gold watch, awarded to Vincent Kelly, high ranking individual judging All Breeds.
Rotating Glory Trophy, awarded to Iowa State College, 2nd ranking team in judging All Breeds.

Country Gentleman.

Zipper Bag, awarded to Vincent Kelly, high ranking individual judging All Breeds.

Starline, Inc.

Radio, awarded P. Archibald, Ontario Agricultural College, second high ranking individual judging All Breeds.

Hoard's Dairyman.

Rotating cup, awarded Ontario Agricultural College, high ranking team judging All Breeds.

THE STUDENTS' NATIONAL CONTEST IN JUDGING DAIRY PRODUCTS

Cornell University won the sweepstakes cup and a scholarship at the Students' Contest in Judging Dairy Products at the Dairy Industries Exposition in Cleveland on October 17. Iowa State College won second place, and Connecticut State College third. Both these colleges were also awarded scholarships. Teams from 23 colleges competed—the greatest number ever to compete in this contest.

Highest individual honors in judging all 4 products were won by L. M. McCalla, of Mississippi State College, who was awarded a gold medal. Silver and bronze medals for second and third places were awarded to Thomas S. Warner, of Iowa State College, and Nathan Andursky, of Cornell University, respectively.

Cornell University was also awarded 2 silver cups for placing first in judging ice cream and cheese. Iowa State College won the silver cup for placing first in judging butter, and Ohio State University received a similar award in the judging of milk.

Gold, silver, and bronze medals were awarded to the individual contestants who won first, second, and third places, respectively, in the judging of each of the four products.

The scholarships, cups, and medals were provided by the Dairy and Ice Cream Machinery and Supplies Association, which Association has sponsored this contest for 9 successive years.

The International Association of Milk Dealers awarded a gold medal to Howard Kizer, University of Illinois, for placing first in judging milk, and the International Association of Ice Cream Manufacturers a gold medal to L. M. McCalla, Mississippi State College, for placing first in ice cream.

Twenty-three teams, representing 22 State Agricultural Colleges and one Provincial Agricultural College of Canada, participated in this, the ninth annual contest sponsored by the Dairy and Ice Cream Machinery and Supplies Association, Inc., and the American Dairy Science Association.

Following are the names of the colleges and individual contestants who won high standings in the contest:

ALL PRODUCTS

Teams		*Individuals*	
1—Cornell University	177.45	1—L. M. McCalla, Mississippi State College	50.00
2—Iowa State College	178.00	2—Thomas S. Warner, Iowa State College	52.50
3—Connecticut State College	193.90	3—Nathan Andursky, Cornell University	55.20
4—Mississippi State College	198.75	4—Lealand G. Sherman, Iowa State College	57.25
5—Michigan State College	199.20	5—Varnum D. Ludington, Cornell University	57.75

ALL PRODUCTS

Teams		*Individuals*	
6—University of Tennessee	200.25	6—P. A. Turner, Jr., University of Tennessee	59.25
7—Ohio State University	203.75	7—Wayne E. Smith, Ohio State University	59.50
8—University of Maryland	215.50	8—Frank Kosikowsky, Connecticut State College	61.25
9—Massachusetts State College	218.00	9—Robert Stephenson, Michigan State College	63.00
10—University of Vermont	226.25	10—Bradley L. Gilbert, Michigan State College	64.25

ICE CREAM

Teams		*Individuals*	
1—Cornell University	65.0	1—L. M. McCalla, Mississippi State College	18.0
2—Massachusetts State College	65.75	2—Marvin Koger, New Mexico College of A. & M. A.	18.75
3—Kansas State College	68.0	3—Charles Rodda, Jr., Massachusetts State College	19.00
4—Iowa State College	69.75	4—P. A. Turner, Jr., University of Tennessee	19.00
5—University of Tennessee	70.0	5—Varnum D. Ludington, Cornell University	19.50
6—Mississippi State College	73.5	5—Thomas S. Warner, Iowa State College	19.5
7—Connecticut State College	76.0	5—Melvin Jensen, South Dakota State College	19.5
8—West Virginia University	76.75	8—Floyd Mecham, Jr., University of Nebraska	20.0
9—University of Nebraska	77.0	8—Willis Faulkender, Kansas State College	20.0
10—University of Maryland	77.75	8—S. H. Thomas, Ontario, Agric. College	20.0
10—Michigan State College	77.75		

BUTTER

Teams		*Individuals*	
1—Iowa State College	30.0	1—Thomas S. Warner, Iowa State College	6.0
2—Cornell University	34.0	2—Clifton Martin, Jr., University of Maryland	7.0
2—University of Maryland	34.0	3—Nathan Andursky, Cornell University	7.5
4—Connecticut State College	35.0	4—Lloyd C. Bowers, University of Maryland	8.0
5—Ontario Agric. College	38.0	5—William C. Kueffner, University of Minnesota	9.5
6—Michigan State College	39.0	6—Jack L. Garvin, West Virginia University	10.0
6—Oklahoma A. & M. College	39.0	7—William J. Nelsone, Connecticut State College	10.5
6—University of Tennessee	39.0	7—Frank Kosikowsky, Connecticut State College	10.5
9—University of Wisconsin	39.5	7—George M. Fausold, Pennsylvania State College	10.5
9—University of Minnesota	39.5	7—Arthur D. Kasler, Ohio State University	10.5
		7—Varnum D. Ludington, Cornell University	10.5
		7—John Anderson, West Virginia University	10.5
		7—Donald W. Glover, Purdue University	10.5

MILK

Teams		*Individuals*	
1—Ohio State University	37.25	1—Howard Kizer, University of Illinois	7.75
2—Michigan State College	38.45	2—Charles Rodda, Jr., Massachusetts State College	8.00
3—University of Vermont	39.25	3—Wayne E. Smith, Ohio State University	8.00
4—New Mexico College of Agric. & Mech. Arts	39.50	4—Arthur D. Kasler, Ohio State University	8.25
5—Iowa State College	41.25	5—Raymond Worrell, New Mexico College of A. & M. A.	10.25
6—Connecticut State College	41.90	6—Edwin M. Hankinson, Michigan State College	10.45
7—Massachusetts State College	45.75	7—Robert E. Plumb, University of Vermont	10.50
8—Cornell University	46.95	8—Lealand G. Sherman, Iowa State College	10.75
9—University of Tennessee	49.25	9—Alva S. Baker, University of Maryland	11.25
10—West Virginia University	49.70	10—Winfred Jacobsen, University of Nebraska	11.75

CHEESE

Teams		*Individuals*	
1—Cornell University	31.5	1—L. M. McCalla, Mississippi State College	7.5
2—Mississippi State College	32.0	2—Arch G. Lamb, Texas Technological College	9.0
3—Texas Technological College	32.5	3—Nathan Arnursky, Cornell University	9.5
4—Iowa State College	37.0	4—Lealand G. Sherman, Iowa State College	10.0
5—Connecticut State College	41.0	5—Wayne E. Smith, Ohio State University	10.5
6—Ohio State University	41.5	5—Thomas S. Warner, Iowa State College	10.5
7—University of Tennessee	42.0	5—Clayburn Harrell, Texas Technological College	10.5
8—Michigan State College	44.0	5—Frank Kosikowsky, Connecticut State College	10.5
9—Pennsylvania State College	46.5	9—Melvin W. Diehl, Pennsylvania State College	11.0
10—University of Vermont	51.5	9—Varnum D. Ludington, Cornell University	11.0
10—University of Maryland	51.5		

AMERICAN DAIRY SCIENCE ASSOCIATION
PRESIDENT'S LETTER

To the Members of the American Dairy Science Association:

As an officer of the Association I readily embrace this opportunity to report to you the progress of certain features of the Association program.

The members should be aware that the publication of the Journal constitutes the major activity of the Association. The financial transactions relating to the Journal are a significant part of the Association operations; for a great many members the Journal comprises the only liaison with the Association; subscriptions constitute a major source of revenue. Because of this situation, the secretary, the editor, the Journal management committee (O. F. Hunziker, A. A. Borland and R. B. Stoltz) and all the officers are alert to every possibility for increasing memberships and subscriptions.

During November a member in each state was requested to serve as a membership representative in his state. Three members in Canada were likewise so requested. All these men responded with a willingness that was most reassuring. Their efforts are proving fruitful. An especial urgency in respect to memberships arises this year because of the new by-laws which prescribe the $5.00 admission fee for new members.

One of the activities of the Association which has heretofore not received adequate recognition is that pertaining to the various committees and subcommittees appointed by the different sections. The Extension, Production and Manufactures Sections all have their committees. Some of these committees are encountering especially perplexing questions; the committee members are working diligently. It is hoped the membership at large will recognize the role these committees play and that every assistance to facilitate the committee activities will be offered.

The activities of some of the general association committees also deserve attention. A committee on Student Chapters was appointed by President Gregory last year. It consists of J. A. Nelson, E. V. Ellington and A. A. Borland. The committee is studying the questions and is making plans to submit its proposals at an early date. Doubtless a definite and acceptable policy with regard to Student Chapters can be adopted.

Harold Macy, H. A. Ruehe and F. B. Morrison were appointed by President Gregory as a committee to modify present rules or formulate new ones pertaining to the Borden Awards. The committee is making a thorough study of all aspects of this matter. In due time this report will be available for consideration. The Association members should be advised, however, that pending the adoption of changes in these rules the procedures as employed the past year will be observed.

Another important committee appointed by President Gregory is the

committee on dairy curricula. The general committee consists of H. B. Ellenberger, H. P. Davis, M. Mortensen, C. E. Wylie, C. L. Roadhouse. The sub-committee on dairy manufactures consists of C. L. Roadhouse, A. D. Burke, J. H. Erb, C. D. Dahle, W. V. Price, R. W. Bell, H. F. Judkins. The sub-committee on dairy production consists of C. E. Wylie, J. W. Bartlett, I. R. Jones, C. N. Shepardson, T. E. Woodward, C. L. Clevenger.

This committee has been at work for more than a year. There is no disposition to effect any undue speed in the committee's deliberations but assurance has been given that a progress report would be forthcoming at the Summer meeting in June. Some Association members assert that the question of the curriculum is one of the most pressing ones confronting dairy departments today.

At the Summer meeting in 1938 action was taken which prescribed the appointment of a resolutions committee to assume certain duties as enumerated in the Journal for August 1938, page 519. The committee appointed is: C. Y. Cannon, D. R. Theophilus, L. S. Palmer, G. G. Gibson, and L. M. Thurston. The attention of the sectional chairmen and secretaries particularly is directed to this committee.

The chairman of the program committee for the Summer meeting in June 1939 is E. V. Ellington. The other members of the committee are automatically appointed by virtue of the fact they are section chairmen; viz. Manufactures, P. A. Downs; Production, H. W. Cave; Extension, S. J. Brownell. The advisory members are the program committee chairmen the past two years, namely, T. S. Sutton for 1938 and H. P. Davis for 1937.

This program committee is well along with its plans for the Summer meeting at Moscow, Idaho, and Pullman, Washington, the week of June 26, 1939. Various unique features of both the technical part of the program and the entertainment are to be offered the members. These features together with the setting for the meeting and the new experience through having our Association assemble for the first time in the Pacific Northwest promise an event of great profit and pleasure.

Yours very sincerely

EARL WEAVER, *President*
American Dairy Science Association

December 30, 1938

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ABSTRACTS OF LITERATURE

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Thurston, L. M.
Totman, C. C.
Trout, G. M.
Tuckey, S. L.

Webb, B.
Weckel, K. G.
White, G. C.
Wilbur, J. W.
Wilster, G.
Wylie, C. E.

Yale, M. W.

JOURNALS

American Creamery and Poultry Produce Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Certified Milk
Cornell Veterinarian

Deutsche Molkerei Zeitung

Endocrinology

Food Industries
Food Manufacture
Food Research

Guernsey Breeders Journal
Ice and Refrigeration
Ice Cream Field
Ice Cream Industry
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Jersey Bulletin
Journal of Agricultural Research
Journal of Agricultural Science
Journal of American Chemical Society
Journal of American Veterinary Medicine Association
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
Journal of Experimental Medicine
Journal of General Physiology
Journal of Heredity
Journal of Genetics
Journal of Infectious Diseases
Journal of London Chemical Society
Journal of Milk Technology
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry
Journal of Physiology

Kaeseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry
Milk Plant Monthly
Molkerei Zeitung

National Butter and Cheese Journal

Pacific Dairy Review
Proceedings of Society of Animal Production
Proceedings of Society of Experimental Biology and Medicine

Tierernährung
Tierzüchter
Trudy Vologodskogo Molochnogo Institut

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zeitschrift für Untersuchtung der Lebensamittel
Zeitschrift für Züchtung. Reihe B. Tierzuchtung und Zuchtungbiologie
Zentralblatt für Bacteriologie
Züchtungskunde

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland
International Association of Ice Cream Manufacturers
International Association of Milk Dealers
National Institute for Research in Dairying, Reading, England
New York Association of Dairy and Milk Inspectors
Prussian Dairy Research Institute, Kiel, Germany
State Agricultural Colleges and Experiment Stations
The Royal Technical College, Copenhagen, Denmark
United States Department of Agriculture

ABSTRACTS OF LITERATURE

BACTERIOLOGY

1. Detecting Thermophilic Contamination in Skim-milk Powder. C. M. SORENSEN, Sealtest Research Laboratories, Baltimore, Md. Food Research, *3*, 4, p. 421. July, Aug., 1938.

A method for determining contamination of dry skimmilk with organisms of the "flat-sour" type, utilizing N/60 sodium or lithium hydroxide for solvation of the dry milk, dextrose-tryptone brom cresol-purple agar for plating and an incubation temperature of 55° C., is described. F.J.D.

CHEESE

2. Methods for Determining Salt in Various Cheeses. J. C. MARQUARDT, N. Y. Agr. Exp. Station, Tech. Bull. No. 249, Sept., 1938.

This publication represents a thorough study of procedures for determining the salt content of several varieties of cheese. It contains a literature review that starts with the original work on this subject by J. Volhard in 1878. A complete review of faulty procedures and the significant developments to produce proper procedures is given

The study has been undertaken because of previous findings at the station which stress the importance of proper salt contents in cheeses.

The modified Volhard method, approved by the American Dairy Science Association, gives reliable results with young cheddar, aged cheddar, roquefort, blue vein, camembert, limburger and cottage cheeses. Other varieties were not studied.

It was possible to obtain reliable results by titrating directly aliquots of solutions prepared from freshly made cheeses less than five days old. Potassium chromate and dichloro-fluorescein gave comparable results when used as indicators for the direct titrations. Two methods for the direct titration have been described.

It is not possible to obtain accurate values with cured cheeses by direct titration.

Water soluble proteins render direct titrations unsuitable for certain cheeses over 5 days old. A study has been made of the influence of time of solution, temperature of water, reaction of the aliquot and like factors in regard to their influences upon direct titrations. J.C.M.

3. Warm Water Washing Improves Sweet Curd Cottage Cheese. L. J. MANUS, Department of Dairy Husbandry, West Virginia University. Milk Dealer, *27*, 12, pp. 40, 70–71, September, 1938.

Washing of soft, properly coagulated curd flakes with warm water was found to result in the production of curd that was not only soft but sweet

in taste. The detailed procedure, as used successfully at the West Virginia Creamery for more than two years, is given. C.J.B.

DISEASE

4. Post Parturient Hemoglobinuria of Cattle. FARQUHARSON, J. AND SMITH, K. W., Colorado State College, Fort Collins, Colorado. Journal of the American Vet. Med. Ass'n. Vol. XCIII—N. S. Vol. 46—No. 1, pp. 37–39, July, 1938.

Referring to this post parturient disease of well nourished mature cows, the authors state that the malady is characterized by its sudden onset and voiding of blood-colored urine, and its appearance principally in winter and spring months. Symptoms may be confused, by casual observation with those of milk fever. The causes of the malady are unknown at present. *Treatment*—place affected cow in clean, quiet surroundings—remove concentrates from ration and give only alfalfa hay of good quality. Use blood transfusion (direct) after signs of weakness develop and repeat as often as maintenance of strength requires. Recovery is slow. *Prevention*—Use dietary measures around time of parturition—remove concentrates from ration, three weeks before and two weeks after parturition and feed only good quality alfalfa hay. The authors warn that this is not a *definite* means of prevention. J.W.W.

5. The "Saturation Method" for the Treatment of Breeding Failures with Wheat-Germ Oil. PACINI, AUGUST J., Minneapolis, Minnesota. J. Am. Vet. Med. Assn. Vol. XCIII—N. S. Vol. 46, No. 4,—pp. 236–238, Oct., 1938.

The author believes that the value of wheat-germ oil may be due to ingredients other than Vitamin E and that the therapeutic use of wheat-germ oil cannot be considered synonomous with Vitamin E therapy. In the saturation method one single original dose of four ounces of wheat-germ oil (not obtained by any solvent process) is administered. Every third day thereafter the animal is given a tablespoonful of wheat-germ oil until the time covered is equivalent to one estrous cycle (21 days). Thereafter the animal is furnished grain feed to which four ounces of wheat-germ oil has been added to each ton of grain feed. Careful observations will show a perceptible improvement in the coat of the animal in from two to three weeks after the initial dose. Generally speaking, animals whose coats fail to display an improved condition will fail to respond favorably in the correction of the breeding disorder. J.W.W.

FEEDS AND FEEDING

6. Feeding Value of Hay Crop Silage. C. F. MONROE, C. C. HAYDEN, A. E. PERKINS, W. E. KRAUSS, C. E. KNOOP, AND R. G. WASHBURN, Ohio Agr. Exp. Sta., Wooster, O. Ohio Exp. Sta., Bimonthly Bull. Vol. XXIII, No. 194, Sept.–Oct., 1938.

Three feeding trials were conducted in which a combination of soybean and corn silage was compared with legume hay and corn silage. Two comparisons were made between acid silage (A.I.V.) made from alfalfa and clover mixtures, and ordinary hay rations.

It was shown that hay crop silages may be satisfactorily fed to replace sun-cured hay and that such feeding may be continued for the winter feeding period without apparent ill effect to the cows.

Alfalfa molasses silage was found to be a valuable supplement for cows on pasture, with indications that under certain conditions it may be more valuable than grain in maintaining production. W.E.K.

FOOD VALUE OF DAIRY PRODUCTS

7. The Place of Milk in Nutrition. C. A. ELVEHJEM, Dept. of Biochemistry, University of Wisconsin. Milk Dealer, *28*: 1, pp. 56–62, October, 1938.

The author shows that while milk is the nearest approach we possess to a complete food, it is deficient in iron, copper, and manganese. When these minerals were added to milk and fed to young rats, the animals grew as well or better than on any other mixture of foodstuffs.

By using milk mineralized with iron, copper, and manganese it was demonstrated that milk produced during September and November gave growth entirely comparable with that obtained on a mixed diet. Milk produced in February and March was much inferior and milk produced during December and January was intermediate in its growth-promoting property. Summer evaporated milk gave a daily gain of 3.6 gm., while winter evaporated milk gave a gain of only 1.7 gm. daily. By various supplements to the winter ration the nutritive value of winter milk was improved.

Results for the pasteurized milk showed that the growth on pasteurized summer milk was identical with that on raw summer milk. However, the gain in weight for pasteurized winter milk was inferior to that for raw winter milk. Pasteurization, therefore, has no marked detrimental effect, as measured with rats, upon the nutritive value of a milk of high nutritive quality, but may further reduce the value of a milk of low nutritive quality.

In addition to the reports on winter and summer milk and the effect of pasteurization, it is reported that lactose cannot be utilized except when

fed with definite amounts of fat. If the fat is absent the sugar will be lost unchanged in the urine. Thus it is necessary that milk be used with its normal fat content. C.J.B.

ICE CREAM

8. Ice Cream and Cakes, Pies, Cookies. ANONYMOUS, Ice Cream Field *32*: 8, pp. 33, 34, 48, August, 1938.

Some of the advantages of selling ice cream and pastry products at the same time are illustrated by specific examples from the industry. Examples are also given to show that difficulties may arise in such an attempted combination. W.C.C.

9. Ice Cream Specialties. KEN FORREST, Ice Cream Field *32*: 9, pp. 20, 21, 22, 37, September, 1938.

Examples of a variety of different types of ice cream packages which have been successfully merchandized are cited.

It is claimed that with a quality product plus a novelty appeal, the 5¢ item can be responsible for a substantial part of the ice cream manufacturers' profits. W.C.C.

10. Autumn Specials. RALPH BARRETT, Ice Cream Field *32*: 9, pp. 7–8, Sept., 1938.

The author recommonds the following basic procedure as a means of successfully advertising ice cream.

1. Hire a competent home economics specialist to draw up fool proof "recipes" involving the use of commercial ice cream in home made desserts.
2. Prepare your advertising campaign on the basis of the amount of money allotted for this purpose.
3. Continue this program even though the results obtained may seem slow in materalizing.

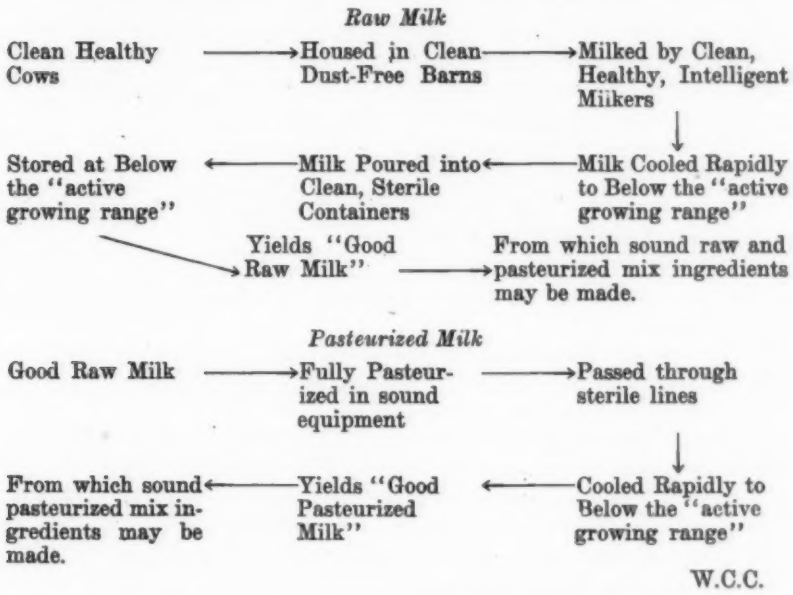
The author lists 14 different combinations of ice cream with other products which he claims have been successfully used in advertising programs based on the above outline. W.C.C.

11. Milk as an Ingredient. DAVIS LEVOWITZ, New Jersey Dairy Laboratories. Ice Cream Field *32*: 7, pp. 23–24. July, 1938.

The author's discussion of this topic can be summarized by the following taken from the article:

Flow Sheet for Good Milk

The Fundamental Consideration for Good Ice Cream Ingredients


Raw Milk
Clean Healthy Cows
Housed in Clean Dust-Free Barns
Milked by Clean, Healthy, Intelligent Milkers
Milk Cooled Rapidly to Below the "active growing range"
Milk Poured into Clean, Sterile Containers
Stored at Below the "active growing range"
Yields "Good Raw Milk"
From which sound raw and pasteurized mix ingredients may be made.
Pasteurized Milk
Good Raw Milk
Fully Pasteurized in sound equipment
Passed through sterile lines
Cooled Rapidly to Below the "active growing range"
Yields "Good Pasteurized Milk"
From which sound pasteurized mix ingredients may be made.

W.C.C.

12. **Frosted Foods.** M. A. CORBETT, New York Group, National Food Distributors Assn., Ice Cream Field *32*: 10, pp. 23, 23, 25, 34, Sept., 1938, 32 p. (11).

The author outlines briefly the early developments of the frosted food industry.

He points out that whereas the early growth was very rapid in many instances that its success will depend upon proper cultivation. He states "competition of the right sort is the thing the industry needs most to give quick freezing a solid footing in the industry."

According to the author many of the large wholesalers of frosted foods have quit the field. He states that confusion in the wholesale and retail branches of this industry is due to the fact that many distributors "are more interested in loading warehouse and store cabinets with merchandise than they are in cooperating to build a permanent, mutually profitable business."

W.C.C.

13. **Advantages of Dry Egg Yolk.** WALTER HALPERT, Stein, Hall & Co., Inc., New York. Ice Cream Field *32*: 7, pp. 16–17, 44. July, 1938.

14. Sanitation and Control. C. W. ENGLAND, Department of Animal and Dairy Husbandry, University of Maryland. Ice Cream Field *32*: 7, pp. 31–32, 42, July, 1938; *ibid.*, 8, pp. 42–47, Aug., 1938.

According to the author ice cream sanitation includes three aims:

1) It should be clean and free from all extraneous matter. 2) It should be safe, that is, it should not contain disease-producing organisms. 3) It should not contain large numbers of miscellaneous bacteria.

He considers the following sources of contamination:

1) equipment. 2) plant operator. 3) ingredients added to mix after pasteurization. 4) retail dispensing of ice cream. Usually the personal factor is the most difficult to control.

The author discusses the more common ways that high bacteria counts are obtained in ice cream, citing work previously published to confirm most of his statements.

He points out that although high bacteria counts in colors and flavors will not ordinarily increase materially the final count of the ice cream, yet such contaminations should be guarded against.

He claims that the greatest sanitary problem of the counter freezer manufacturer so far as equipment is concerned is the freezer itself. Detailed directions for washing and "sterilizing" it are given. Where steam and hot water are not available chlorine is the only method left. This method leaves the equipment wet and is therefore objectionable. He strongly condemns the use of a cloth to dry the freezer.

He points out that often the high bacteria counts in ice cream served to the public are due to contaminations from the vendor's scoop. Figures taken from the American Journal of Public Health, vol. 27, 1007–9, 1937, show the importance of properly caring for the scoops.

The following is a summary by the author of the main points in producing and dispensing ice cream of excellent sanitary quality.

1) Use raw materials of an excellent sanitary quality and pasteurize at 160° F. or higher for 30 minutes, or if you purchase a pasteurized mix, insist that it be of an excellent sanitary quality and properly pasteurized.

2) Keep the mix below 40° F. and for a period not longer than two days until frozen.

3) Avoid contamination of opened fruits, fruit concentrates, nuts, extracts and colors. Keep these items covered and refrigerated.

4) Properly clean and sterilize the freezer and other equipment with which the mix or ice cream comes in contact.

5) Keep scoops on a dry rack and rinse in running water before and after use.

6) Use common sense coupled with cleanliness. W.C.C.

15. Frosted Foods for Ice Cream Manufacturers. C. Q. SHERMAN, C. Q. Sherman Co., N. Y. Ice Cream Field *32*: 8, pp. 12–13, 22, August, 1938.

The author claims that frosted foods can be handled by ice cream manufacturers to advantage because they already have hardening room facilities that can be used to store frosted foods. In addition delivery trucks used for ice cream can also be used to deliver frosted foods.

The author also states that the dairy routes are potential outlets for frosted foods, but it is to the advantage of the distributor to handle established brands rather than try to sell his own brand of frosted foods.

He claims that in his experience health authorities have not objected to keeping packaged ice cream and packaged frosted foods in the same cabinet, but objections might be raised if bulk ice cream were dispensed from the same cabinet. W.C.C.

16. Testing Mix Ingredients. D. LEVOWITZ, Ice Cream Field *32*: 8, pp. 39–40, August, 1938.

The author briefly outlines some of the more obvious characteristics of part of the common ingredients used in ice cream indicating certain precautions such as cooling, etc., which should be followed in preserving their quality. Limitations of bacterial contents of acceptable quality are given for the products discussed. W.C.C.

17. Package Ice Cream. KEN FORREST, Ice Cream Field *32*: 7, 6, 8, July, 1938; Ice Cream Field *32*: 8, pp. 9–11, August, 1938.

Proper selection of color and design are emphasized in choice of packages for ice cream. The author also warns the manufacturer against letting dealers dispense his ice cream in unidentified packages. He claims further that every effort should be made by the manufacturer to build up name preference with the consumer.

The author cites many examples in which ice cream has been successfully merchandized in factory filled packages. W.C.C.

MILK

18. Electric Pasteurization Feature of Air Conditioned Pine Grove Dairy. ANONYMOUS. Milk Dealer, *28*: 1, pp. 68–70, October, 1938.

A description of the Pine Grove Dairy, Schenectady, New York, in which has been installed a stainless steel milk pasteurizer of a new design.

No external heat is applied to the milk. Electricity generates heat right in the milk itself. In 45 seconds' time, milk previously cooled to a tempera-

ture of 50° F. or less is raised to a pasteurizing temperature of 162° F., held at that temperature for 15 seconds, and then cooled again to 50° F. or less and delivered by gravity to the bottling machine. Operation is automatic and continuous. C.J.B.

19. **The Manufacture of Pump Churned Cultured Buttermilk.** GEORGE SAUER, Los Angeles, Calif., and L. V. TOWT, Oakland, Calif. Milk Dealer, *28*: 1, pp. 76–82, October, 1938.

Detailed procedure is given for the manufacture of churned buttermilk in which a specially designed centrifugal pump is used in place of a better churn.

It is concluded that the quality of buttermilk is determined by the quality of the starter and that the churned flavor and aroma is the by-product of the citrovorus and paracitrovorus organisms in the starter and not the absorption of a churned flavor from the churn. C.J.B.

20. **"Use of Milk" Survey Completed in City of Chicago.** ANONYMOUS. Milk Dealer, *27*, 12, pp. 62–68, September, 1938.

The research bureau of De Pauw University, after personally interviewing 7,170 families in the City of Chicago, in a "use of milk" survey, summarize their findings as follows:

Quite a large percentage of families interviewed had boarders or outsiders living with them—about 19.4 per cent, and the number having children under 16 years was rather small. Average number of quarts of milk consumed by families of two, three, and four is much lower than government estimates for the actual needs of such families. The average for Chicago families of two was 5.82 quarts, for families of three it was 9.28 quarts, and for a family of four was 10.93 quarts. The government estimate for requirements of such families was: family of two, 7 quarts or its equivalent in other milk products, family of three, 14 quarts or its equivalent, and a family of four, 17 quarts, or its equivalent. The average for all families 7,170 was 11.63 quarts weekly, and the average sized family was 4.7 persons.

Milk prices in Chicago showed wider variation than average prices for the whole United States. The Chicago price had a tendency to go up faster than the average. This was, also, true of other large cities. Notwithstanding this relationship of the price of milk in large cities, the conditions affecting the cost of milk vary much for different cities such as New York and Chicago. Furthermore, the housewife has not been sold on the price of fluid milk delivered, bought at grocery stores, or bought at cash milk stores.

Some rather interesting information was brought out regarding seasonal fluctuation in sale of milk. It was found that the peak month (October) in Chicago is not the same for New York or Boston, and other very large cities. The nationality of the people living in certain cities would have some influence

on milk consumption. Cities with a large preponderance of Irish and Germans would show a greater consumption per capita. The Irish rank first, and the Germans second as milk drinkers. The native whites come third. The Negro drinks less milk than any other group in this country.

A smaller number of housewives were buying cream than in previous surveys. It was found that approximately 25 per cent bought cream from cash milk stores. Native whites used the most cream per day; the Irish were a poor second, and the Germans were third.

The housewife is not sold on 13 cents a quart for milk. No mention was made that milk is any better than in other nearby cities where the price of milk is lower. 2,804 out of 7,170 housewives said they would buy more milk if it was cheaper. They probably had in mind more than one cent decrease in price.

Reasons why the housewife preferred one company over another were: first, quality; second, service; third, flavor; fourth, buttermilk; etc.

C.J.B.

21. Composite Sampling of Milk and Cream. S. CRAIG ALEXANDER. Milk Dealer, *27*, 12, pp. 38, 48, September, 1938.

A proportional sampling device tested and approved by the Department of Agriculture of the State of California is provided with four scales on a dial. These are so arranged with respect to the retaining or sample chamber (with which they are directly connected through the connecting rod) that when a patron's selected scale (on the dial) is set at the weight of the shipment as shown on the weighing scale, the individual sample taken is always proportionate to the weight of the shipment sampled, and the accumulated total will be within the range of volume of the composite sample desired. Setting the scale is extremely simple. C.J.B.

22. What's Wrong with Fluid Milk Markets? CHESTER FLETCHER, R. R. 3, Waukesha, Wis. Milk Dealer, *27*, 12, pp. 36–37, 73, September, 1938.

A review of the trend in delivery and plant operating costs. The author concludes that in the fluid milk business the sales will continue to drift downward and the producers' share of the consumers' dollar continue to decline until labor is compelled to meet the producer on equal terms—receive pay for what they actually do and nothing else. C.J.B.

23. Insulated Milk Tanks. ANONYMOUS. Milk Dealer, *27*, 12, pp. 34–35, 68, September, 1938.

A complete description of the insulated milk-cooling tank which is being constructed throughout the Milwaukee milk shed. C.J.B.

24. Ultra-Violet Ray Pasteurization of Milk. S. MANCOVITZ, Reiter Dairy Co., Akron, Ohio. Milk Dealer, *27*, 12, pp. 33, 58, September, 1938.

It was found possible to sterilize milk in less than 45 seconds' exposure to ultra-violet ray. Such milk, however, was unmarketable due to off-flavors. Using an average time of 19 seconds, an average reduction in bacterial counts from 69,000 per cc in the untreated raw milk to 4,500 per cc in the treated milk was obtained. The taste and smell of the milk was not affected by the shorter time exposure. While these results were obtained with practical large volumes of milk, further extensive work is required to indicate the practical potentialities of ultra-violet ray pasteurization. C.J.B.

Editor's note: It is questionable whether this process should be called pasteurization.

25. The Consumption of Dairy Products in Burlington, Vermont (1935–36). H. B. ELLENBERGER AND J. T. STEARNS, Vermont Agric. Exper. Station, Burlington, Vt. Bull. *433*, May, 1938.

The consumption of fluid milk and other dairy products, per family and per capita, in Burlington, Vt., during 1935–36, was determined by a house-to-house survey. All sections of the city were covered by this survey which included 3,616 families and 15,258 persons or about three-fifths of the population. The following summary sets forth the percentage of all families using the different products and the average consumption per family and per capita for all families and for the families that used the product.

Per capita and per family consumption of dairy products

	Percentage of families using the product	Average consumption			
		Families using		All families	
		Per family	Per capita	Per family	Per capita
Fresh milk, pints daily	94.8	4.10	.97	3.89	.92
Canned milk, tall cans weekly	35.0	3.81	.84	1.27	.30
Heavy cream, ½ pints weekly	56.7	2.54	.62	1.44	.34
Butter, pounds weekly	90.7	2.66	.64	2.41	.57
Butter substitute, pounds weekly	14.0	2.57	.48	.36	.09
Cheese,* pounds weekly	61.9	.90	.21	.56	.13
Milk equivalent, pounds yearly	100.0	5,017	1,189	5,017	1,189

* Including cottage cheese.

In addition it shows the variations in rates of consumption by different families according to income, size, nationality, etc., and discloses the more important reasons for restricted usage as well as consumer reactions to quality, price, etc. J.M.F.

26. Factors Causing Variations in Milk Returns. C. G. McBride, Ohio Agr. Exp. Sta., Wooster, O. Ohio Exp. Sta. Bimonthly Bull. Vol. XXIII, No. 193, July–August, 1938.

The following factors causing variation in milk returns are discussed: prevailing market prices, butterfat content, seasonal production, marketing plans, special market, transportation costs, and financial responsibility of buyers. W.E.K.

MISCELLANEOUS

27. Progress of Agricultural Research in Ohio, 1936–1937. Ohio Agricultural Experiment Station Bull. 592, 142 pp., 1938. (Forty-sixth annual report.)

Brief summaries are presented of the results obtained in many projects, of which the following are of particular interest.

Livestock versus grain farming. C. G. Williams (pp. 24–26).

Palatability of soybean oil meals. C. F. Monroe (p. 77).

Peas, oats, and flax for cows. C. F. Monroe and L. E. Thatcher (pp. 77–78).

A method for measuring the loss of juice and volume-weight relationship at different pressures of ensiled crops. A. E. Perkins (pp. 78–80).

Corn-soybean silage versus alfalfa hay and corn silage. C. C. Hayden, C. F. Monroe, W. E. Krauss and A. E. Perkins (p. 80).

Loss of carotene in haymaking. W. E. Krauss and R. G. Washburn (p. 81).

A study of the hydrogen-ion concentration of the contents of the bovine rumen. C. F. Monroe and A. E. Perkins (pp. 81–82).

The determination of ammonia and urea in milk. A. E. Perkins (p. 82).

Whole milk and magnesium carbonate for bone growth in dairy calves. C. E. Knoop, W. E. Krauss, and C. C. Hayden (p. 83).

Raw versus pasteurized milk. W. E. Krauss and R. G. Washburn (pp. 83–84).

Pasture milk versus dry feed milk. W. E. Krauss (pp. 84–85).

Studies on the vitamin C content of milk. R. G. Washburn and W. E. Krauss (pp. 85–86).

Effect of vitamin A on mineral assimilation. W. E. Krauss, C. F. Monroe, and R. G. Washburn (p. 86).

Studies on the absorption of ultraviolet light by dairy calves. W. E. Krauss and C. E. Knoop (pp. 87–88).

Effect of ultraviolet light on the health of dairy cattle. W. E. Krauss, B. H. Edgington, C. F. Monroe, and C. C. Hayden (pp. 88–89).

The artificial induction of oestrus in the milk goat during the anoestrus period. T. S. Sutton and W. R. Krill (p. 89).

The effects of vitamin A deficiency on reproduction. T. S. Sutton and J. B. Brief (pp. 90–91).

The stability of carotene and vitamin A in a mixed ration. R. M. Bethke, P. R. Record, and O. H. M. Wilder (p. 99).

The loss of carotene in dehydrated alfalfa leaf meal stored under different conditions. O. H. M. Wilder and R. M. Bethke (p. 100).

Mastitis in cattle. A. J. Schalk, B. H. Edgington, and T. S. Sutton (p. 103).

Effect of mechanical processing of feeds on mastication and rumination. C. H. Kick, Paul Gerlaugh, A. J. Schalk, and E. A. Silver (pp. 103–105).

Nutritional status of college women in relation to their dietary habits. H. McKay and M. B. Patton (pp. 108–110).

Effect of milk marketing plans on return to producers. C. G. McBride (p. 112).

Changes in volume of milk deliveries by individual milk producers. R. W. Sherman (p. 113).

Factors influencing farmers to market cooperatively. G. F. Henning (pp. 115–116). W.E.K.

28. The Use of Metals in the Dairy Industry. II. Nickel and Its Alloys. G. GENIN. Engineer E. P. C. I. Paris, France, Le Lait *18*: No. 178, 785–805, September–October (1938).

A review is given in which the following phases of the subject are discussed; physical, mechanical and chemical properties of nickel, Monel metal and Inconel, commercial forms of nickel and its alloys, corrosion of nickel and its alloys by milk and by washing and sterilizing solutions and the influence of nickel on the food value of milk including the vitamins. A.H.J.

29. The Function of Collecting Womans' Milk at Erfurt. MARIE-ELISE KAYSER. Le Lait *18*: No. 178, 805–812, September–October (1938).

In some 700 mothers from whom "surplus" milk was collected, the quantities available varied from 150 grams to 1500 grams per day. The quality of the milk was controlled by determining the acidity. The normal acidity of mothers' milk is much lower than that of cows' milk. Thus mothers' milk has an acidity of 1 to 2 degrees S–H, pH 7.25–6.94, while that of cows' milk is 6 to 8 degrees S–H. The fat content of the mothers' milk that was collected varied between 0.6% and 9.7%. Mothers' milk generally has a fat content of about 3.2%. Methods of distinguishing between mothers' milk and cows' milk are discussed. When exposed to solar light in a special glass container mothers' milk gives a blue fluorescence while under the same conditions cows' milk gives a yellow fluorescence. By using the biologic serum method developed by Koschucharoff the presence of 5% of cows' milk can be readily detected in mothers' milk. Mothers' milk above the supply required is made into dry milk powder. A.H.J.